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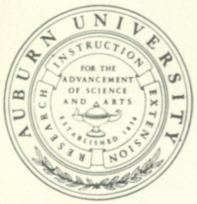

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GEOLOGY AND GROUND-WATER RESOURCES OF THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.

GEOLOGICAL SURVEY OF ALABAMA BULLETIN 77

GEOLOGICAL SURVEY OF ALABAMA

Philip E. LaMoreaux
State Geologist

DIVISION OF WATER RESOURCES

Doyle B. Knowles
Chief Hydraulic Engineer

BULLETIN 77

GEOLOGY AND GROUND-WATER RESOURCES OF THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.

Prepared by the United States Geological Survey
in cooperation with the
Water Works and Sewer Board of the City of Russellville
and the Geological Survey of Alabama

UNIVERSITY, ALABAMA

1964

STATE OF ALABAMA

Honorable George C. Wallace, Governor

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July 7, 1964

Honorable George C. Wallace
Governor of Alabama
Montgomery, Alabama

Dear Governor Wallace:

I have the honor to transmit the manuscript of a report entitled "Geology and Ground-Water Resources of the Russellville Area, Alabama" by Richard R. Peace, Jr., with the request that it be printed as Bulletin 77 of the Geological Survey of Alabama.

The report discusses the geology of the Russellville area and identifies the sand and gravel in the Tuscaloosa Group and solution cavities in the Bangor Limestone as the most productive aquifers in the area. These two aquifers are possible sources of water supply for industrial use and for the city of Russellville. One test well drilled as a part of this study obtains water from both aquifers and was pumped at rates ranging from 119 to 350 gallons per minute.

Respectfully,

Philip E. LaMoreaux
State Geologist

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CONTENTS

	Page
Abstract	1
Introduction	2
Location of area	2
Purpose and scope	2
Previous investigations	5
Well-numbering system	6
Acknowledgments	6
Geography	6
Physiography and drainage	6
Climate	9
Development	9
Geology	11
Stratigraphy and structure	11
Geologic units and their water-bearing properties	14
Mississippian System	14
Hartselle Sandstone	14
Bangor Limestone	15
Pennington Formation	20
Pennsylvanian System	22
Pottsville Formation	22
Cretaceous System	25
Tuscaloosa Group	25
Quaternary System	26
Regolith	26
Ground water	28
Source	28
Occurrence, movement, and storage	28
Water-table and artesian conditions	30
Water-level fluctuations and their significance	30
Recovery and use	39
Test drilling	39
Test pumping	44
Quality of water	53
Summary and conclusions	60
Selected bibliography	62
Basic data	65

CONTENTS

ILLUSTRATIONS

(All plates in pocket)

Plate 1. Geologic map of the Russellville area.
2. Location of test wells and springs in the Russellville area.
3. Ground-water movement in the Russellville area, 1961.

Page

Figure 1. Area studied and areas of other ground-water studies in Alabama 3
2. Physiographic divisions of the Russellville area 7
3. Precipitation at the Russellville station 2, 1954-61 10
4. Geologic section showing the Bangor Limestone-Tuscaloosa Group contact in sec. 12, T. 7 S., R. 13 W. 17
5. Changes in discharge of springs J-4 and J-41 and precipitation at the Belgreen station 19
6. Changes in discharge of springs B-55 and B-125 and precipitation at the Russellville station 2 27
7. Changes in water level in well RTW-4 due to changes in barometric pressure 31
8. Changes in water level in wells RTW-1, RTW-2, and RTW-4, and 5-day precipitation at the Russellville station 2 33
9. Changes in water level in well B-108, and 5-day precipitation at the Russellville station 2 34
10. Changes in water level in wells B-58 and C-37, and 5-day precipitation at the Russellville station 2 35
11. Changes in water level in wells B-9, B-45, C-23, K-21, K-48, and N-17, and precipitation at the Russellville station 2 36
12. Changes in water level in wells C-12, I-8, J-30, and J-60, and precipitation at the Belgreen station 37
13. Changes in water level in well RTW-1 correlated with precipitation at the Russellville station 2, May 22-29, 1961 38
14. Lithologic and electric log of well RTW-1 40
15. Lithologic and electric log of well RTW-2 41
16. Lithologic and electric log of well RTW-6 42
17. Lithologic and electric log of well RTW-7 43
18. Fluctuation of water level due to pumping well RTW-4, January 1961 47
19. Fluctuation of water level due to pumping well RTW-4, September 1961 48
20. Variation of specific capacity, well RTW-4 49

CONTENTS

Page

Figure 21. Fluctuation of water level due to pumping well RTW-7 50
22. Fluctuation of water level due to pumping well RTW-1 51
23. Fluctuation of water level due to pumping well RTW-2 52

TABLES

Table 1. Geologic units that crop out in the Russellville area, and their water-bearing properties 12
2. Test pumping data on U.S. Geological Survey test wells in the Russellville area 45
3. Chemical analyses of water from selected wells and springs in the Russellville area 54
4. Records of test wells in the Russellville area 66
5. Drillers' logs of the city of Russellville's test wells ... 69
6. Records of selected wells and springs in the Russellville area 72
7. Sample descriptions of U.S. Geological Survey test wells in the Russellville area 74

GEOLOGY AND GROUND-WATER RESOURCES OF THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.

ABSTRACT

A detailed study of the ground-water resources and geology of the Russellville area, Alabama, was started in July 1959 by the U.S. Geological Survey in cooperation with the Water Works and Sewer Board of the city of Russellville and the Geological Survey of Alabama. The Russellville area occupies about 192 square miles in north-central Franklin County, Ala., and lies within the Coastal Plain and Appalachian Plateaus physiographic provinces. The climate is mild and temperate; the average annual temperature is 61° F. From 1954 through 1961 the area had an annual average rainfall of 52 inches.

Geologic units exposed in the area are the Hartselle Sandstone, Bangor Limestone, and Pennington Formation of Late Mississippian age; Pottsville Formation of Pennsylvanian age; Tuscaloosa Group of Late Cretaceous age; and regolith of Quaternary age. The regolith, ranging from 0 to 40 feet in thickness, covers all the area except the part underlain by the Tuscaloosa. The regional dip of the rocks in the area is toward the south at about 57 feet per mile.

Sand and gravel in the Tuscaloosa Group and solution cavities in the Bangor are the most productive aquifers in the area and are possible sources for potential development of a water supply for the city of Russellville. Well RTW-4 develops water from both geologic units and was pumped at rates varying from 119 to 350 gpm (gallons per minute). The specific capacities of the well determined from pumping tests range from 5.8 to 10.7 gpm per foot of drawdown. Well RTW-7 developed in the Bangor was pumped at rates of 100 and 200 gpm. The specific capacities determined for these rates of pumping were 3.6 and 4.3 gpm per foot of drawdown. The range in values of specific capacities for the two wells is due primarily to incomplete development of the aquifer. Well RTW-1 develops water from the Tuscaloosa and was pumped at 33 gpm. It had a specific capacity of 1.2 gpm per foot of drawdown. Small ground-water supplies are developed in the Hartselle and Pottsville; the Pennington is not an aquifer in the area.

The chemical quality of ground water in the area is generally good. Two water samples from well B-9, finished in the Bangor, had a sulfate content of 1,012 and 1,060 ppm (parts per million) and a dissolved solids content of 1,760 and 1,730 ppm. Two water samples from well B-45, finished in the Hartselle, had a sulfate content of 532 and 1,260 ppm, a fluoride content of 7.1 and 12.0 ppm, and a dissolved solids content of 1,750 and 2,870 ppm. Water from well B-34, finished in the Hartselle, had a dissolved solids content of 540 ppm. Twenty-two

other samples collected from 15 sources were of good chemical quality within the standards set by the U.S. Public Health Service.

INTRODUCTION

A detailed study of the ground-water resources and geology of the Russellville area, Alabama, was started in July 1959 by the U.S. Geological Survey in cooperation with the Russellville Water Works and Sewer Board and the Geological Survey of Alabama. This report contains the results of that study and should be used with the interim report, "Geology and Ground-Water Resources of the Russellville Area, Alabama, an Interim Report" (Peace, 1962), and the reconnaissance report, "Geology and Ground-Water Resources of Franklin County, Alabama, a Reconnaissance" (Peace, 1963).

LOCATION OF AREA

The Russellville area is in north-central Franklin County, Ala. (fig. 1), and includes the Russellville, Frankfort, Spruce Pine, and Isbell 7½-minute quadrangles, an area of about 192 square miles. The area is within all or parts of Tps. 6, 7, and 8 S., and Rs. 10, 11, 12, and 13 W.

PURPOSE AND SCOPE

Russellville for many years has had difficulty in obtaining an adequate source of water for municipal supply. The present supply is obtained from Cedar Creek; however, in periods of drought this source is inadequate. An increase in the municipal supply is dependent upon the development of the ground-water resources. A detailed ground-water investigation was made in the Russellville area to determine the occurrence, availability, quantity, and quality of ground water as an aid to the development of a supplemental water supply.

The work accomplished was as follows:

1. Inventoried 271 wells to determine their location, construction, depth, water level, water-bearing formation, yield, method of recovery, and use.

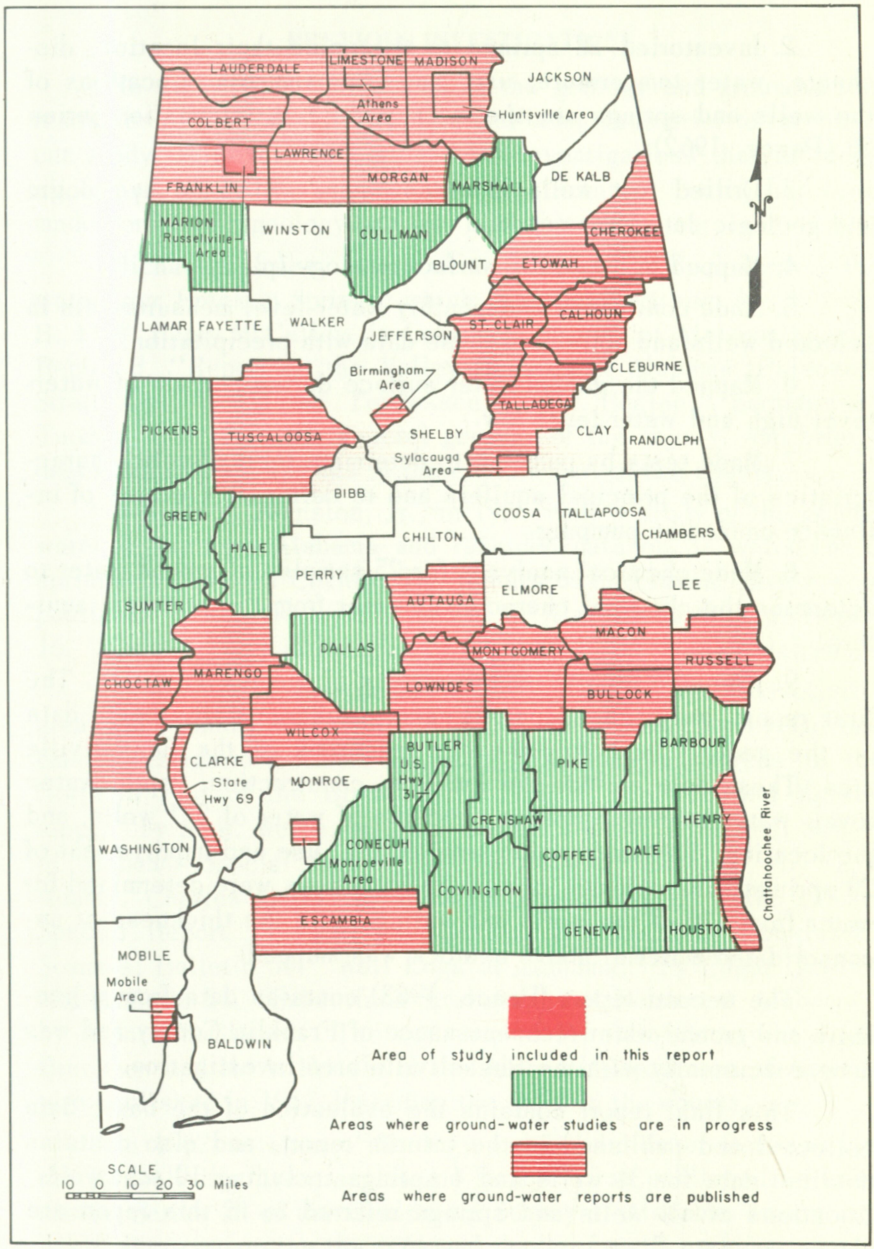

Figure 1.—Area studied and areas of other ground-water studies in Alabama.

2. Inventoried 28 springs to determine their location, discharge, water temperature, use, and improvements. Locations of the wells and springs are shown on plate 1 in Information Series 28 (Peace, 1962).

3. Drilled test wells in areas where additional hydrologic and geologic data were needed.

4. Mapped in detail the surface geology (pl. 1).

5. Made continuous and monthly water-level measurements in selected wells and correlated these data with precipitation.

6. Mapped the ground-water surface during periods of water-level high and water-level low.

7. Made tests by pumping to determine the hydraulic characteristics of the principal aquifers and to delineate the area of influence caused by pumping.

8. Made chemical analyses for 25 samples of ground water to determine the chemical character of water from the principal aquifers.

9. Prepared reports on the results of the investigation. The first report, an interim report (Peace, 1962), contains basic data on the geology and ground-water resources of the Russellville area. These data include the location, construction, depth, water level, water-bearing formation, and use of water of 271 wells, and the location, discharge, water temperature, use and improvement of 28 springs. The chloride content and hardness were determined for water from 170 of the wells and springs, and the thickness of unconsolidated material above bedrock was mapped.

The second report (Peace, 1963) contains data from a geologic and ground-water reconnaissance of Franklin County and was done concurrently with the Russellville area investigation.

This final report contains the evaluation of the basic data collected and published in the interim report, and also contains detailed data for 34 wells and 4 springs including 10 test wells. Locations of all wells and springs referred to in this report are shown on plate 2.

PREVIOUS INVESTIGATIONS

No detailed investigations of the geology and ground-water resources of the Russellville area had been made prior to the present study. However, several general investigations that included all or part of the Russellville area and Franklin County had been made concerning geology and (or) ground-water resources.

Michael Tuomey, in his second report, 1858, describes the water from Franklin Springs, which is in the NW¼ sec. 16, T. 6 S., R. 11 W. Henry McCalley, in Geological Survey of Alabama Special Report 8, "Report on the Valley Regions of Alabama (Paleozoic Strata), pt. 1, On the Tennessee Valley Region," paraphrases Tuomey, describes the general geology of the county, and briefly describes mineral springs in the eastern part of the county.

William D. Johnston, Jr., in 1933 made a study of the ground water in northern Alabama and recorded data on 37 wells and 8 springs in Franklin County. The results of this investigation were published by the Geological Survey of Alabama in Special Report 16, "Ground Water in the Paleozoic Rocks of Northern Alabama."

Other reports that describe the geology of the Russellville area and Franklin County include U.S. Geological Survey Oil and Gas Investigations Chart OC-62, "Mississippian Rocks of the Northern Part of the Black Warrior Basin, Alabama and Mississippi," by S. W. Welch, and four reports by the Geological Survey of Alabama—Special Report 14, "Geology of Alabama," by G. I. Adams, Charles Butts, L. W. Stephenson, and C. Wythe Cooke; Special Report 15, "Oil and Gas in Alabama," by Douglas R. Semmes; Bulletin 50, "Well Logs of Alabama," by Edgar Bowles; and Bulletin 64, "Subsurface Stratigraphy of Northwest Alabama," by Winnie McGlamery. The soil map of Franklin County by L. G. Brackeen and H. A. Ponder of the Alabama Department of Agriculture published in 1957 describes the soils in the county.

In 1962, a report, "Geology and Ground-Water Resources of the Russellville Area, an Interim Report" was published as Information Series 28 of the Geological Survey of Alabama. It contains basic data concerning the type and depth of wells, springs, water-bearing formations, water levels, methods of lift, uses of water, chemical analyses, and the general geology of the Russellville

area. A report, "Geology and Ground-Water Resources of Franklin County, a Reconnaissance," was published as Bulletin 72 of the Geological Survey of Alabama. It is a general report on the geology and the occurrence, availability, and chemical quality of ground water in Franklin County. These reports are by Richard R. Peace, Jr.

WELL-NUMBERING SYSTEM

Test wells drilled during this investigation are numbered consecutively in the order they were drilled. The number is preceded by the letters RTW to indicate Russellville Test Well. Thus, well RTW-3 in plate 2 is the third test well drilled in this investigation. The numbering system used for all other wells referred to in this report is the same as was used in the interim report (Peace, 1962).

ACKNOWLEDGMENTS

The author expresses appreciation to the H. W. Peerson Drilling Supply Co. for the driller's logs used in this report (table 5); to Shook and Fletcher Co. of Russellville, Ala., for driller's records used in the preparation of figure 4; and to Mrs. D. C. Pace, Franklin County Librarian, who made accessible the material on the history and development of Russellville and Franklin County.

Acknowledgment is made to members of the Water Works and Sewer Board, Dr. J. Y. Blake, chairman, and to the Board of Commissioners of the city of Russellville, Dr. J. D. Burns, mayor, for their assistance in making the cooperative program a success.

GEOGRAPHY

PHYSIOGRAPHY AND DRAINAGE

The Russellville area lies within two physiographic provinces; the Coastal Plain province and the Appalachian Plateaus province (Johnston, 1930). The Coastal Plain province is represented in the area by the Fall Line Hills district of the East Gulf Coastal Plain section, and the Appalachian Plateaus province by the Cumberland Plateau section, which is divided into three districts; the Warrior Basin, the Moulton Valley, and the Little Mountain (fig. 2). This physical division differs from Fenneman's (1938,

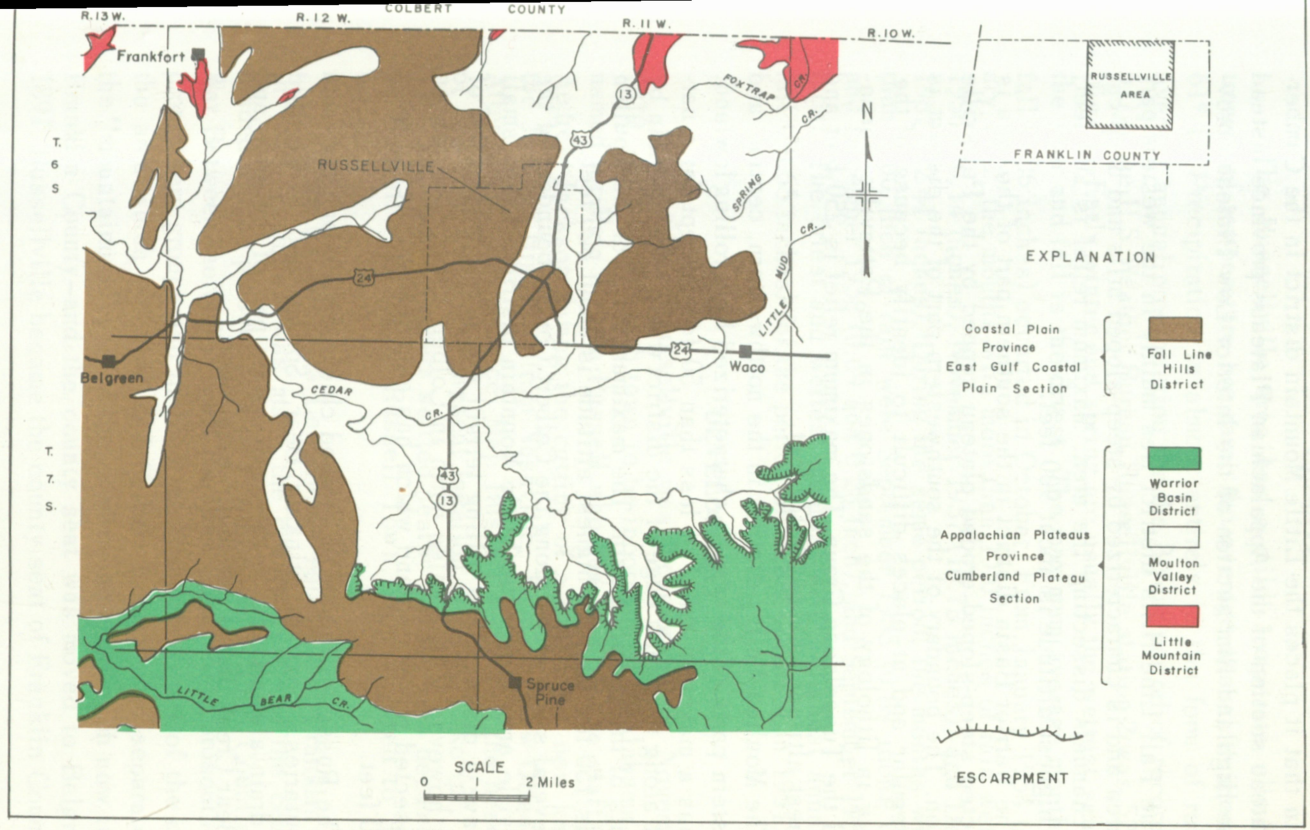

Figure 2.—Physiographic divisions of the Russellville area.

pl. III) in that it places the Little Mountain district in the Cumberland Plateau section of the Appalachian Plateaus province instead of in the Highland Rim section of the Interior Low Plateaus province.

The Fall Line Hills district lies mainly in the western part of the area and is characterized by steep-sloped hills and deep-cut stream channels dissecting the area. Maximum relief is 200 feet, and the highest altitude is about 900 feet.

The Warrior Basin district in the southern part of the area is a dissected steep-sloped eroded plateau capped by the Pottsville Formation. The boundary of the southwestern part of the district is very irregular and at places difficult to identify because of the similarity in lithology of the sandstones in the Pottsville Formation and the Tuscaloosa Group. The maximum relief is 250 feet and the highest altitude is about 1,070 feet.

The Moulton Valley district in the northwestern, central, and northeastern parts of the area is characterized by a rolling lowland, which has a maximum relief of less than 50 feet except for a narrow belt along the south edge of the district where it is overlain by sediments of the Warrior Basin. The maximum relief of the Moulton Valley is 150 feet and the highest altitude is about 820 feet.

Several small areas along the Colbert County boundary of the Russellville area are in the Little Mountain district. These small areas have a dissected to rolling terrain and a maximum relief of 70 feet; however, 2 to 3 miles north in Colbert County the terrain is a dissected plateau upland which has a maximum relief of more than 250 feet.

The Russellville area is drained chiefly by Cedar Creek and its tributaries. Foxtrap, Stinking Bear, Spring, and Little Mud Creeks drain a small area in the northeastern part of the area, and Little Bear Creek drains the southwestern part.

CLIMATE

The Russellville area has a mild, temperate climate. Extremes of temperature are rare; the average annual temperature is 61° F. Precipitation is almost entirely in the form of rain. The average annual precipitation for the 8-year period of record (1954-61) at the U.S. Weather Bureau Russellville station 2 was 52 inches (fig. 3). Early winter and spring are usually the wettest seasons of the year and fall is the driest. The maximum average monthly rainfall (5.86 inches) occurred in October. From January 1954 to January 1962, the months with more than 10.0 inches of rain were April 1956 (10.14 inches), November 1957 (10.73 inches), and December 1961 (12.41 inches). During the same period, the months with less than 1.00 inch of rain were September 1955 (0.89 inch), October and December 1958 (0.69 and 0.28 inch), and September 1961 (0.25 inch). The driest and wettest months and the highest annual rainfall (58.65 inches) for the period of record occurred in 1961.

DEVELOPMENT

The city of Russellville was incorporated on November 27, 1819, and was the 12th town to be incorporated in Alabama. It was named for Maj. William Russell who had been on the staff of Gen. Andrew Jackson during the cutting of a trail road, now known as the Jackson Highway, from Nashville, Tenn., to New Orleans, La. After his military service, Maj. Russell settled on the headwaters of Mud Creek near the present location of Sloss Lake (pl. 1). In a short time other pioneers settled nearby and the area became known as Russell's Valley or Russell Town, later changed to Russellville.

When the Alabama Legislature established Franklin County in 1818, Frankfort was made the county seat and the county included all the present area of Franklin and Colbert Counties. The War Between the States split Franklin County into prosouthern and pronorthern groups and in 1867 the "lowland" part of the county—the area which now includes Colbert County—was separated from the "mountainous" part of the county—the area which now includes Franklin County—and the county seat was moved to Belgreen. In 1891, Russellville became the county seat of Franklin County.

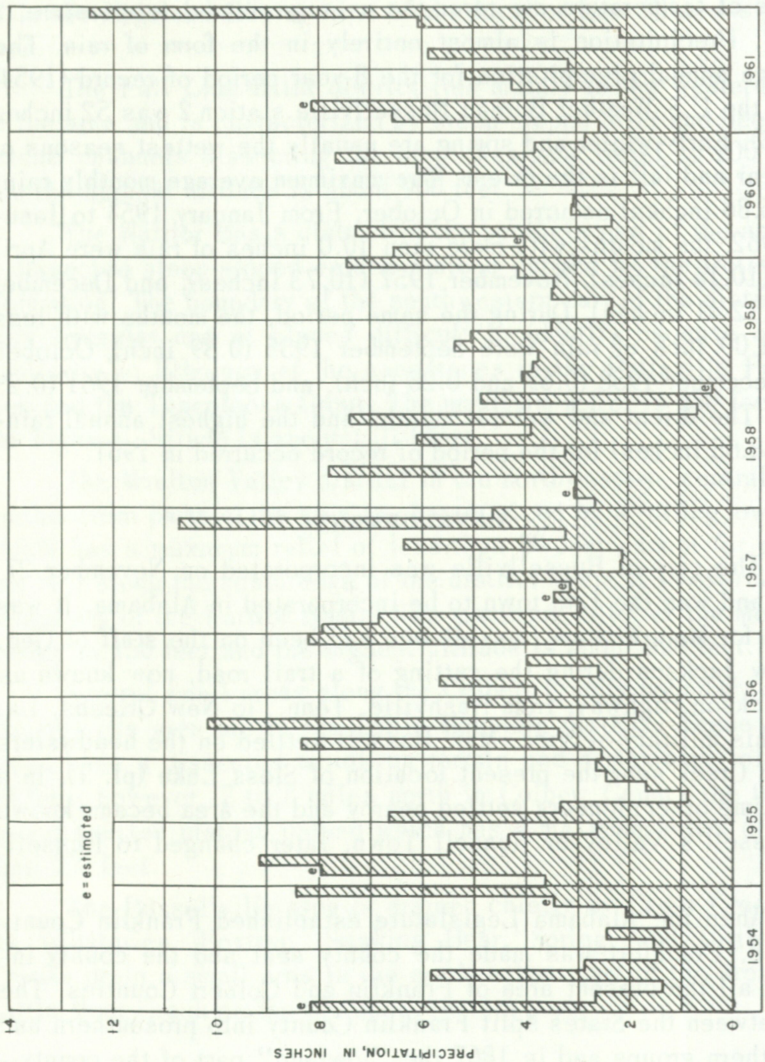

Figure 3.—Precipitation at the Russellville station 2, 1954-61.

The economy of the Russellville area has been based on agriculture, particularly cotton, and the mining of brown iron ore and limestone. In recent years the economy has been greatly improved by the establishment of several small industries in Russellville and larger industries located along the Tennessee River. Diversification in agriculture and livestock, especially in poultry raising, is another factor that has influenced the economy of the area.

The Russellville area is served by the Southern Greyhound Lines and the Southern Railway. The Muscle Shoals-Mobile Short Route, U.S. Highway 43, runs north and south through the area and Alabama Highway 24 runs east and west across the area. There is a network of paved county roads that serve more than 85 percent of the population in the rural area.

GEOLOGY

The rocks that crop out in the Russellville area are unconsolidated and consolidated and consist of rock debris, gravel, clay, sand, shale, sandstone, and limestone. The age, thickness, physical description, and water-bearing characteristics of the geologic units to which these rocks have been assigned are summarized in table 1. The distribution of these geologic units in the outcrop are shown on plate 1.

The Golconda Formation, the Tuscumbia Limestone, and the Fort Payne Chert of Mississippian age, and the Knox Dolomite of Late Cambrian and Early Ordovician age have been penetrated by water or oil test wells in the Russellville area. These formations were not included in table 1 because of their unimportance as aquifers. Water from the Tuscumbia, Fort Payne, and Knox is high in chloride content, which increases with depth (Bowles, 1941, p. 25, 27).

STRATIGRAPHY AND STRUCTURE

The formations exposed in the Russellville area are the Hartselle Sandstone, Bangor Limestone, and Pennington Formation of Late Mississippian age; the Pottsville Formation of Pennsylvanian age; and the Tuscaloosa Group of Late Cretaceous age. A

Table 1.—*Geologic units that crop out in the Russellville area, and their water-bearing properties*

System	Unit	Thickness (feet)	Description	Properties
Quaternary	Regolith	0-40	Weathered rock debris, consisting of soil, slope wash, alluvium, and terrace gravel.	Yields small supplies to many wells; several of the wells are dry during droughts. Spring J-41 had a minimum discharge of 15 gpm (gallons per minute) during 1960-61. The water is very hard but low in chloride content (Peace, 1962).
Cretaceous	Tuscaloosa Group (undifferentiated)	0-146	Sand, clay, and gravel, yellow, orange, red, and red-purple, irregularly bedded; the gravel is cherty and the sand is quartzose. Brown iron ore occurs in some areas.	Yields supplies up to 350 gpm in some places; generally yields supplies adequate for farm and domestic use.
Pennsylvanian	Pottsville Formation	180	Shale, alternating black to light brownish- or yellowish-gray beds, fissile to thin-bedded; gray fine- to coarse-grained quartzose massive sandstone, generally weathered greenish to reddish gray to black.	Yields small supplies for domestic use; water occurs in openings along bedding and joint planes, and in the beds of porous sandstone. Water is low in chloride content and soft to moderately hard.

Mississippian	Pennington Formation	60-100	Shale, red and green, interbedded with thin layers of gray crinoidal limestone.	Not an aquifer.
	Bangor Limestone	0-445	Limestone, yellowish- to very light to dark-gray, medium crystalline to dense, crinoidal, oolitic, in part silty or cherty; basal 25 to 120 feet is yellowish gray calcareous shale interbedded with lenticular thick- to thin-bedded crinoidal limestone.	Yields supplies up to 200 gpm in a few places; most supplies are of limited quantity and water levels are low during dry seasons. Water occurs in openings along fractures, joints, and bedding planes, and in solution cavities. The water is generally hard.
	Hartselle Sandstone	120-328	Sandstone, light- to yellowish-gray, very fine to medium-grained, friable, thick-bedded to massive, locally calcareous or silty, or thin-bedded and including layers of black shale.	Yields supplies of less than 2 gpm of moderately hard to hard water. Water from one source was high in sulfate and fluoride content.

mantle of regolith of Quaternary age covers most of the area. The formations in the Russellville area dip toward the south at about 57 feet per mile with no apparent structural anomalies. However, results of test drilling by a local mining company indicate either erosional features (stream channels or sinkholes) or pre-Cretaceous faulting in the Bangor causing slumping of the overlying Tuscaloosa Group (oral communication, J. E. Morris, 1962).

GEOLOGIC UNITS AND THEIR WATER-BEARING PROPERTIES

MISSISSIPPIAN SYSTEM

HARTSELLE SANDSTONE

The Hartselle Sandstone of Late Mississippian age was named by Smith (1894) for exposures at Hartselle, Ala., and was included as a unit of the Bangor or limestone phase of the Mountain Limestone. Butts (1926, p. 193-195) divided the Hartselle, and other rock units, from the Bangor Limestone and correlated the Hartselle with the Hardinsburg Sandstone of the Mississippi and Ohio valleys. In the Russellville area the Hartselle is a distinct mappable unit and is overlain conformably by the Bangor Limestone.

DISTRIBUTION

The Hartselle Sandstone crops out in the northern part of the area at six localities: in the extreme northwest and northeast corners of the area; at the community of Frankfort; 2 miles east of Frankfort on the headwaters of Tollison Creek; in the bed of Cook Creek in sec. 6, T. 6 S., R. 11 W.; and along U.S. Highway 43 at the Colbert County boundary (pl. 1). The extent of the outcrops along Tollison Creek, along U.S. Highway 43, and in the northeast corner of the area were determined from the regolith; therefore, the boundaries of these areas on the geologic map (pl. 1) are only approximately located and appear as a dashed line.

LITHOLOGY AND THICKNESS

The character of the Hartselle Sandstone is variable but generally the formation is composed of light- to yellowish-gray very fine to medium-grained friable thick-bedded to massive sand-

stone. Locally the Hartselle is calcareous or silty, or thinly bedded and includes layers of black shale. Not more than 50 feet of Hartselle is exposed in the area and all of the outcrops are weathered. Well RTW-2 (pl. 2) penetrated 120 feet of Hartselle (fig. 15). The thicknesses reported in two well logs are 160 feet (McGlamery, 1955, p. 88-92) and 328 feet (Bowles, 1941, p. 26-27).

WATER SUPPLY

The Hartselle Sandstone in the Russellville area is a poor aquifer. Wells generally yield less than 2 gpm (gallons per minute) of moderately hard to hard water. Water from one well (B-45; table 3) was high in sulfate and fluoride content according to the U.S. Public Health Service standards (1962).

BANGOR LIMESTONE

The Bangor Limestone of Late Mississippian age was named by Smith (1890, p. 155-157) for exposures at Bangor, Blount County, Ala. Smith divided the pre-Carboniferous rocks of Alabama into the upper or calcareous member and the lower or siliceous member and the Bangor was included in the upper member. Butts (1926, p. 195, 199) restricted the Bangor to the limestone above the Hartselle Sandstone and below the Pennington Formation.

DISTRIBUTION

The Bangor Limestone is exposed in most of the valley regions of the Russellville area (pl. 1). The Moulton Valley extending eastward from Rockwood has a maximum width of 5 miles in the Russellville area and is underlain by the Bangor. Northwest of Rockwood the Bangor is exposed along Cedar Creek. A narrow outcrop of less than a quarter of a mile in width is exposed along Little Bear Creek in the southwest corner of the area.

STRATIGRAPHIC RELATIONS

The Bangor Limestone in the Russellville area overlies the Hartselle Sandstone. In the southern quarter of the area the Pennington Formation of Late Mississippian age conformably overlies the Bangor but in the remainder of the area the Tuscaloosa Group

of Late Cretaceous age unconformably overlies the Bangor.

LITHOLOGY AND THICKNESS

There are many facies changes in the Bangor Limestone. In general, the Bangor consists of yellowish- to very light to dark-gray medium crystalline to dense crinoidal oolitic limestone in part silty or cherty, and yellowish- to dark-gray fossiliferous calcareous shale. The basal 25 to 120 feet of the Bangor is locally yellowish-gray calcareous shale interbedded with lenticular thick- to thin-bedded crinoidal limestone which crops out from Frankfort eastward along the Colbert County boundary. The yellowish-gray (locally called buff) oolitic beds of limestone occur in the upper part of the formation, cropping out around the community of Rockwood. The thickness of this oolitic limestone is about 30 feet. Building stones are quarried from the oolitic limestone in the Bangor at the community of Rockwood. At the present rate of mining, the known amount of oolitic limestone at Rockwood will last about 100 years (oral communication, R. B. Dill, 1962). The oolitic limestone beds east of the city of Russellville and around the community of Waco have been mined out.

Pre-Cretaceous erosion of the Bangor caused a thinning and a large variation in thickness (fig. 4) from the eastward-trending escarpment (pl. 1) in the southern part of the area northward to the Colbert County boundary. The thickness of the Bangor varies from 0 to 445 feet. There are no complete sections of the Bangor in the Russellville area; however, Jones (1928) records several detailed sections of the oolitic limestone and gives a general section of the Bangor in the Moulton Valley and environs.

A generalized geologic section of the Bangor in the Russellville area is as follows:

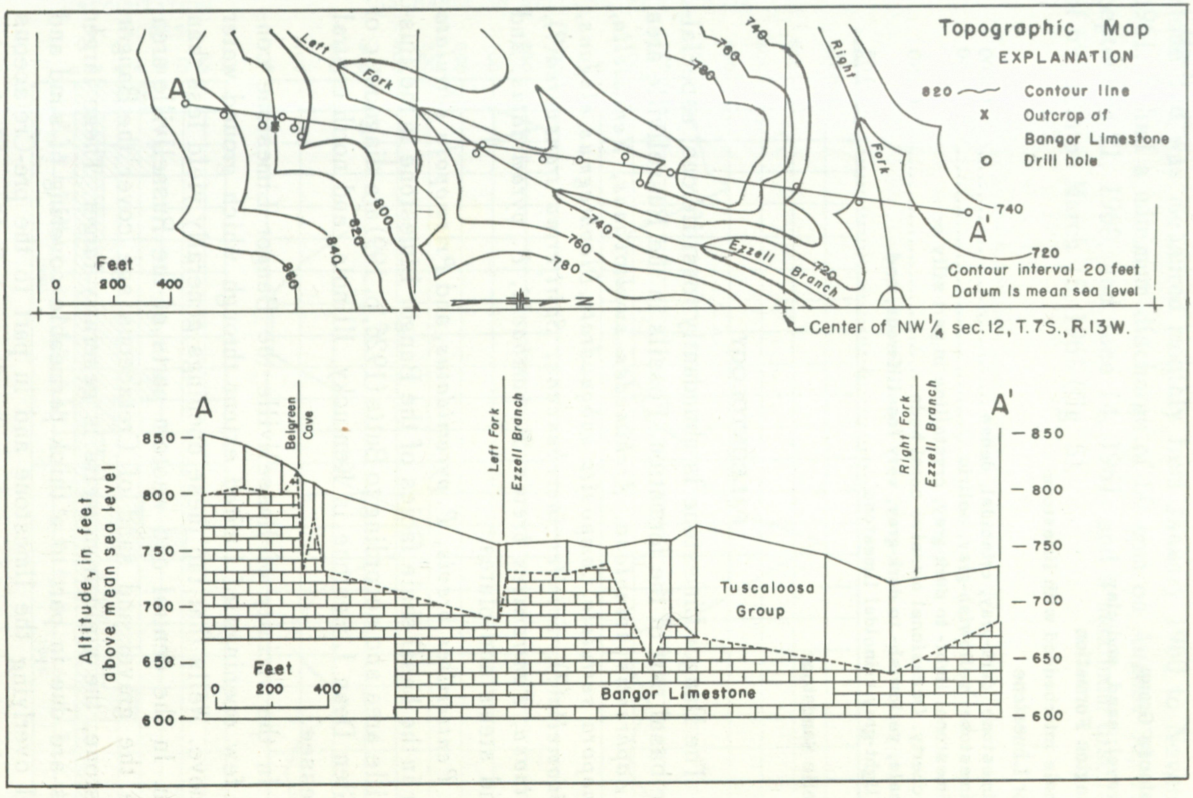

Figure 4.—Geologic section showing the Bangor Limestone-Tuscaloosa Group contact in sec. 12, T. 7 S., R. 13 W.

	Thickness (feet)
Tuscaloosa Group	
Gravel, sand, and clay	
Pennington Formation	
Shale interbedded with limestone	
Bangor Limestone	
Limestone, dark-gray, crinoidal, dense	0-100
Limestone, yellowish-gray, oolitic	0- 30
Limestone, light- to dark-gray, crystalline in part silty or cherty. Occasional massive coral beds	0-150
Shale, yellowish- to dark-gray, very fossiliferous, and light-gray crinoidal limestone	0-165
	0-445
Hartselle Sandstone	

PALEONTOLOGY

The Bangor Limestone is abundantly fossiliferous, especially the basal part of the formation. Fossils in the Russellville area are: *Zaphrentis spinulosa, Archimedes swallovanus, Fenestella, Prismopora serrulata, Composita subquadrata, Diaphragmus elegans, Rhipidomella*(?), *Spirifer increbescens, Spiriferina transversa*(?), *S. spinosa, Pentremites brevis, P. hambachi, P. pyramidatus,* and crinoid stems and plates.

Pentremites brevis, P. pyramidatus, and *Prismopora serrulata* occur in the basal shale facies of the Bangor Limestone in the Russellville area and according to Butts (1926, p. 199) are diagnostic of the Glen Dean Limestone in Kentucky, Illinois, and north-central Tennessee.

In the vicinity of Russellville the Bangor Limestone contains few openings of limited extent through which ground water can move. Wells that tap these openings generally yield less than 5 gpm. In the central and western parts of the Russellville area where the gravel and sand of Cretaceous age cover the Bangor Limestone, the yield from wells is generally larger. These larger yields are due in part to a thick permeable covering of sand and gravel overlying the limestone and in part to the pre-Cretaceous erosion leaving more channels and collapsed rock in this locale; both factors aid in the storage capacity and movement of ground water.

Spring J-4 (pl. 2 and table 6) issues from the Bangor Limestone and was measured monthly from January 1960 to November 1961. It had a minimum discharge of 50 gpm on August 30, 1960, September 21, 1960, and June 14, 1961, and a maximum discharge of 690 gpm on March 15, 1961 (fig. 5).

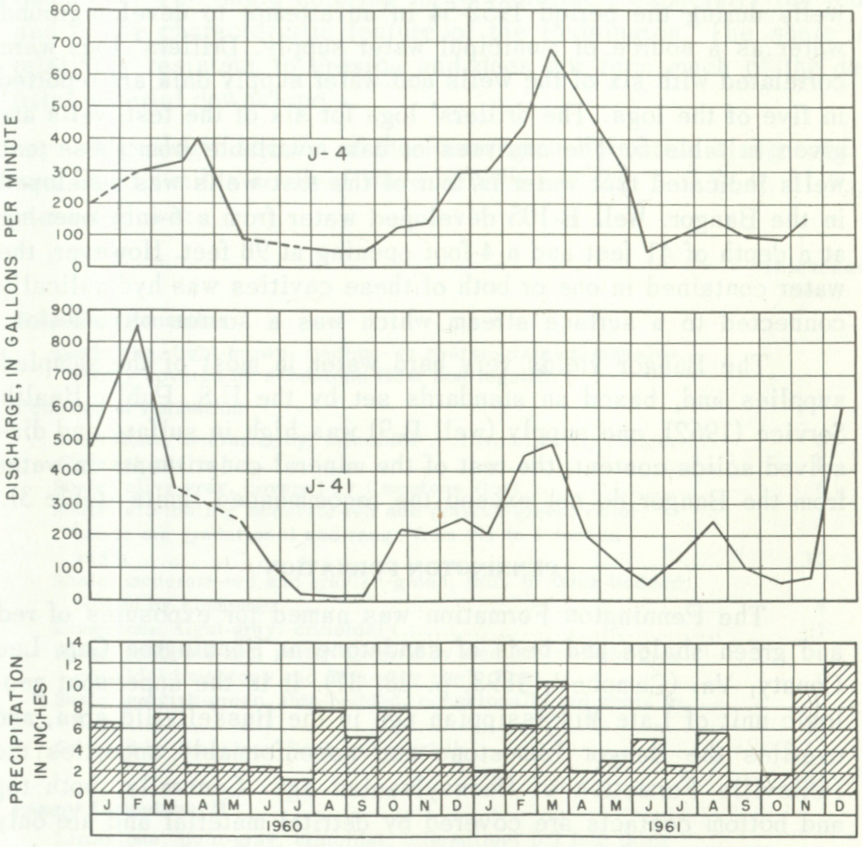

Figure 5.—Changes in discharge of springs J-4 and J-41 and precipitation at the Belgreen station.

Wells RTW-1, RTW-4, and RTW-5 (pl. 2 and table 4) tap the Tuscaloosa Group and the Bangor Limestone; however, based on hydrologic and hydraulic data collected during drilling and the hardness of water, the main source of water to these wells is from the Tuscaloosa Group. Well RTW-2 (pl. 2 and table 4) yielded 38 gpm from the Bangor on November 3, 1960 (fig. 23). In the summer of 1955 the well was pumped dry (oral communication, J. C. Steincipher, 1962). Well RTW-7 (pl. 2 and table 4) yielded 200 gpm from the Bangor on October 18-19, 1961 (fig. 21).

The city of Russellville contracted for the drilling of 18 test wells during the period 1952-54 in an attempt to develop ground water as a source of municipal water supply. Drillers' logs were correlated with six of the wells and water supply data are reported in five of the logs. The drillers' logs for six of the test wells are given in table 5. The analyses of data available from these test wells indicated that water in four of the test wells was developed in the Bangor. Well B-105 developed water from a 6-inch opening at a depth of 41 feet and a 4-foot opening at 98 feet. However, the water contained in one or both of these cavities was hydraulically connected to a surface stream which was a source of pollution.

The Bangor yields very hard water in most of the sampled supplies and, based on standards set by the U.S. Public Health Service (1962), one supply (well B-9) was high in sulfate and dissolved solids content; the rest of the mineral constituents in water from the Bangor do not exceed the recommended limits (table 3).

PENNINGTON FORMATION

The Pennington Formation was named for exposures of red and green shales and beds of sandstone at Pennington Gap, Lee County, Va. (Campbell, 1893, p. 28, 37). It is the uppermost geologic unit of Late Mississippian age in the Russellville area, and overlies the Bangor Limestone and unconformably underlies the Pottsville Formation of Pennsylvanian age. Generally, both top and bottom contacts are covered by detrital material and are only partially exposed.

DISTRIBUTION

The Pennington crops out in the southwest corner of the Russellville area along Little Bear Creek and along the base of the escarpment westward from sec. 27, T. 7 S., R. 12 W. (pl. 1). It is not an aquifer in the Russellville area.

LITHOLOGY AND THICKNESS

The Pennington consists of about 60 to 100 feet of red and green shale layers interbedded with thin layers of gray crinoidal limestone. The shale coloring is very distinct, especially the red, and is the characteristic feature of the Pennington. The shale is relatively resistant to erosion and does not form much of the detrital material downslope.

A geologic section of the Pennington Formation along county road 75, 3.5 miles south of Waco in NW¼ sec. 23, T. 7 S., R. 11 W., is as follows:

	Thickness (feet)
Pottsville Formation	
Sandstone, light-brown, medium- to coarse-grained, massive. Partly covered by sandstone float and regolith	
Pennington Formation	
Limestone, medium-gray, crinoidal	1
Covered interval	6
Shale, olive-gray, covered by limestone float	6
Shale, alternating moderate-red and grayish-green; color bands are gradational and range from 0.1 to 1 foot in width	12
Shale, moderate-red and grayish-green, thin- to thick-bedded; broken by slumpage	6
Limestone, light-gray, crinoidal	1
Shale, moderate-red, partly covered by medium- to light-gray crinoidal limestone and dark-gray shale float	6
Shale, grayish-green, thin-bedded; occasionally red spots in beds	11
Covered by limestone float and regolith	12
	61
Bangor Limestone(?)	
Limestone, light-gray, crinoidal; intermittent 0.2 foot thick discontinuous argillaceous seams; partly covered by gray to moderate yellowish-brown regolith	6
Covered by limestone and gravel float	4

Geologic section—Continued

	Thickness (feet)
Bangor Limestone(?)—Continued	
Limestone, light-gray, coarsely crystalline, crops out in 0.3 to 1 foot ledges; moderate yellowish-brown to moderate-brown regolith between limestone ledges, partly covered by limestone float	12
Covered interval	9
Limestone, light-gray, coarsely crystalline, crinoidal	.9
Limestone, olive-gray, argillaceous, soft	1.1
Covered interval	20
Limestone, light- to dark-gray, coarsely crystalline, hard, crinoidal	6
Covered by sandstone float	6
Covered by moderate yellowish-brown regolith and discontinuous layers 1 to 2 feet thick of crinoidal limestone	5
Bottom of hill	
	70.0

PALEONTOLOGY

The limestone generally contains crinoid stems cemented together with *Archimedes* occurring near the top of the formation.

PENNSYLVANIAN SYSTEM

POTTSVILLE FORMATION

The Pottsville Formation of Pennsylvanian age was named by Lesley (1876, p. 221-227) from cuttings from a gas well at Pittsburg, Pa. The exact type locality was not stated by Lesley, however, typical localities are in the anthracite coal fields of northeastern Pennsylvania. The Pottsville in Alabama has been divided into four fields based on their size and productiveness of coal: Warrior, Cahaba, Coosa, and Plateau (Butts, 1926, p. 209).

DISTRIBUTION

The lower part of the Pottsville Formation crops out in the southern quarter of the area (pl. 1). It has been totally eroded in the central and northern parts of the area. In the south-central part of its area of outcrop, the Pottsville is partly covered by a mantle of Cretaceous sediments, however, along Little Bear Creek, in the southwestern part of the area, there are many good exposures An escarpment exposing the Pottsville runs eastward from sec. 27, T. 7 S., R. 12 W. (pl. 1).

STRATIGRAPHIC RELATIONS

The Pottsville is the uppermost Paleozoic rock cropping out in the Russellville area. It lies unconformably on the Pennington Formation, however, this contact is generally obscured by slumpage of the Pottsville. The Tuscaloosa Group unconformably overlies the Pottsville in most of the south-central and southeastern parts of the area.

LITHOLOGY AND THICKNESS

The Pottsville in the area consists of about 180 feet of alternating beds of sandstone and shale. The sandstone ranges from green to red and from black to light gray; unweathered exposures are gray. The sandstone is fine to coarse grained, quartzose, and massive. The shale beds are black to light brownish or yellowish gray, and are fissile to thin bedded. Butts (1926, p. 209) describes the Pottsville Formation as a monotonous succession of beds of shale and sandstone.

A geologic section of the Pottsville Formation along U.S. Highway 43 in SW¼ sec. 25 and NW¼ sec. 36, T. 7 S., R. 12 W. is as follows:

	Thickness (feet)
Tuscaloosa Group	
Top of hill	
Sand, brown, partly varicolored, fine-grained, quartzose; small amount of cherty gravel	10
Covered interval	5
Gravel (hardpan), varicolored, cherty, rounded, maximum diameter of 0.25 foot	3
	18
Pottsville Formation	
Sandstone, grayish-brown, medium-grained, massive	4
Covered by gravel	7
Sandstone, grayish-brown, medium-grained, massive, partly covered	8.5
Shale, black and sandstone(?) covered by shaly debris	5.5
Shale, black, thin-bedded	5
Sandstone, pale yellowish-brown to grayish-brown, fine- to medium-grained, massive	17
Covered interval	9

Geologic section—Continued

	Thickness (feet)
Pottsville Formation—Continued	
Sandstone, grayish-brown, fine-grained, massive; occasional discontinuous dark-gray to black 0.1 to 0.25 foot shale layers	10
Sandstone, grayish-brown, fine-grained, massive	8.5
Sandstone, grayish-brown, medium-bedded, massive, interbedded with black thin-bedded shale	5
Shale, black, fissile to thin-bedded, partially weathered light brownish gray	2.5
Sandstone, grayish-brown, fine- to medium-grained, massive, interbedded with black fissile to thin-bedded shale	5.8
Sandstone, greenish-gray to grayish-brown to black, medium-grained, thin-bedded, interbedded with black fissile shale	2.9
Sandstone, dark greenish-gray partly weathered red and black, fine-grained, massive	2
Shale, black, fissile to thin-bedded	4
Sandstone, dark greenish-gray partly weathered red and black, fine- to coarse-grained, massive, rarely includes about 1 foot thick black fissile shale layers	32.5
Shale, black partly weathered yellowish gray, fissile, in layers 1 to 2 feet thick interbedded with light-brown to varicolored coarse-grained slightly glauconitic sandstone in layers 0.2 to 2 feet thick	16
Covered by blocks of sandstone and shale float	7
Covered interval	8.5
Sandstone, moderate yellowish-brown weathered varicolored, fine-grained, massive. Badly broken by slumpage(?)	2.7
Shale, dark-gray, weathered yellowish gray, fissile	.8
Covered interval	15
	179.2
Pennington Formation	
Shale, red and green	

WATER SUPPLY

Ground water in the Pottsville Formation occurs in openings along bedding and joint planes and in the beds of porous sandstone. Many supplies are developed in the formation; however, the area of recharge is restricted by the geographic position of the escarpment and only small supplies sufficient for domestic use are available to wells. Water in the Pottsville is generally low in chloride content and soft to moderately hard (Peace, 1962, p. 11).

CRETACEOUS SYSTEM

TUSCALOOSA GROUP

The Tuscaloosa Group of Late Cretaceous age was named for Tuscaloosa, Tuscaloosa County, Ala., and for the Tuscaloosa (Black Warrior) River by Smith and Johnson (1887). The Tuscaloosa Group has been divided elsewhere in Alabama into the Coker and Gordo Formations (Drennen, 1953), however, this division was not made in the Russellville area.

DISTRIBUTION

The Tuscaloosa caps all ridges and hills except in the southeast corner of the area (pl. 1). Many of the hillside slopes and narrow valley floors are partly covered by the slope-wash from the Tuscaloosa making contacts difficult to locate. The contacts between the Tuscaloosa Group and underlying formations have been approximately located on plate 1.

STRATIGRAPHIC RELATIONS

The Tuscaloosa lies unconformably on the Bangor Limestone and the Pottsville Formation. In parts of the Russellville area the Tuscaloosa is overlain by regolith; however, because of the similarities in lithology no attempt was made to differentiate the two units.

LITHOLOGY AND THICKNESS

The Tuscaloosa consists of irregularly bedded sand, clay, and gravel varying in many shades of yellow, orange, and red. The gravel is predominantly rounded chert and includes some pebbles of limestone; the sand is generally light colored quartz. Brown iron ore (limonite) occurs in some of the Tuscalooss where it is underlain by the Bangor Limestone. Brown iron ore is strip mined from the base of the Tuscaloosa in the area west of the city of Russellville. Many of the outcrops are stained reddish brown by iron-bearing minerals precipitated from water that has percolated through the brown iron ore bodies and ferruginous sands.

The average thickness of the Tuscaloosa penetrated in test drilling is 88 feet (table 7). However, figure 4 shows that the thickness of the Tuscaloosa can vary greatly within relatively short

distances because of the irregular pre-Cretaceous erosion surface on the Bangor.

WATER SUPPLY

Water from the Tuscaloosa supplies many domestic and farm needs through wells and springs, and numerous unused springs flow from the sand and gravel beds (Peace, 1962). Data from two springs issuing from the Tuscaloosa are included in this report. During the period of record, spring B-55 (table 6) had a minimum discharge of 20 gpm on January 11, 1960 and a maximum discharge of 33 gpm on March 17, 1960 (fig. 6). During the period of record, 1960-61, spring B-125 (table 6) had a minimum discharge of 6 gpm on October 23, 1961 and a maximum discharge of 14 gpm on May 18, 1960 (fig. 6).

Data from pumping tests indicate that the Tuscaloosa will yield as much as 350 gpm to wells in some places. Well RTW-4 (pl. 2 and table 2) was pumped continuously at 300 gpm on September 21-22, 1961, for 1,055 minutes (fig. 19) and 350 gpm on January 25, 1961, for 380 minutes (fig. 18). However, most wells developed in the Tuscaloosa yield small to moderate supplies of water adequate for farm and domestic use. The changes in water level in well RTW-1, due to pumping at 33 gpm, are shown in figure 22.

The quality of water from the Tuscaloosa is generally good; the mineral content is low according to the standards of the U.S. Public Health Service and the water is moderately hard.

QUATERNARY SYSTEM

REGOLITH

DISTRIBUTION

The regolith in the Russellville area is of Recent age and is restricted to the residual soil, slope wash, alluvium, and terrace gravel derived from the Hartselle Sandstone, Bangor Limestone, Pennington Formation, and Pottsville Formation. It mantles the entire area except for small denuded areas around and east of the

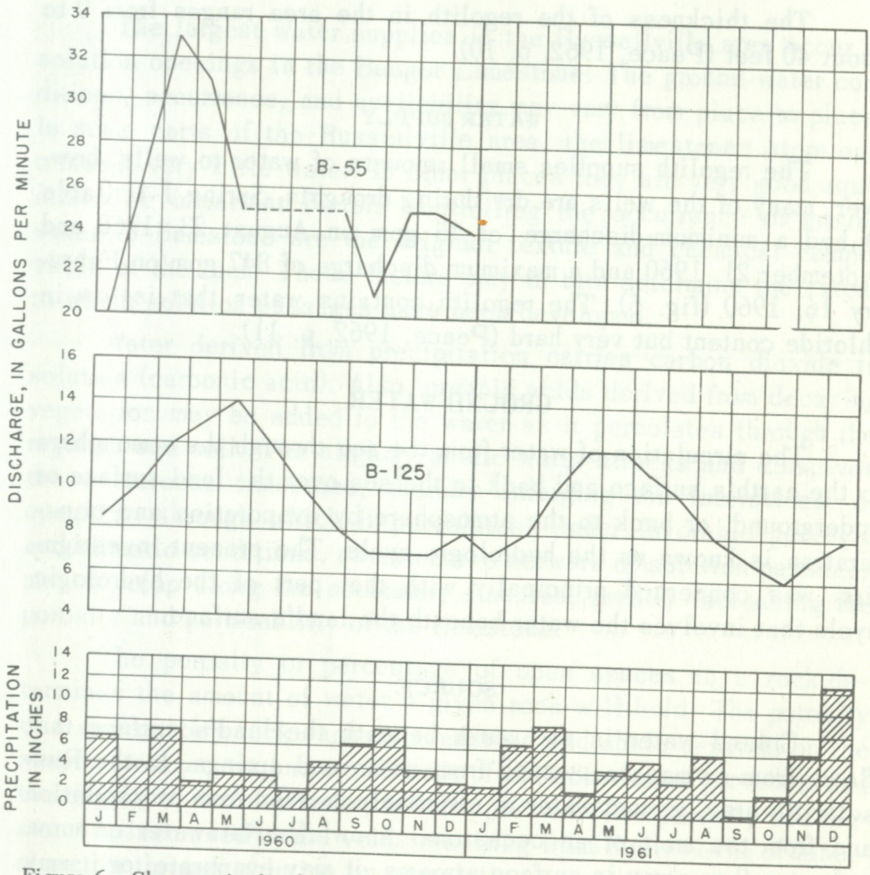

Figure 6.—Changes in discharge of springs B-55 and B-125 and precipitation at the Russellville station 2.

community of Waco. The surface features of the regolith are discussed in the text of a detailed soil map for Franklin County (Brackeen and Ponder, 1956).

STRATIGRAPHIC RELATIONS AND THICKNESS

The regolith is the youngest rock unit in the Russellville area and covers all the bedrock in the area except the Tuscaloosa Group. The regolith developed on the Tuscaloosa was not differentiated because of similarities in lithology.

The thickness of the regolith in the area ranges from 0 to about 40 feet (Peace, 1962, p. 10).

WATER SUPPLY

The regolith supplies small amounts of water to wells, however, many of the wells are dry during droughts. Spring J-41 (table 6) had a minimum discharge of 15 gpm on August 23, 1960 and September 21, 1960 and a maximum discharge of 847 gpm on February 16, 1960 (fig. 5). The regolith contains water that is low in chloride content but very hard (Peace, 1962, p. 11).

GROUND WATER

The circulation of water from the sea through the atmosphere to the earth's surface and back to the sea over the land surface or underground, or back to the atmosphere by evaporation and transpiration is known as the hydrologic cycle. The present investigation was concerned principally with that part of the hydrologic cycle that involves the water beneath the land's surface.

SOURCE

Ground water is the water beneath the land's surface that flows from or may be pumped from wells and springs. In the Russellville area, ground water is ultimately derived from precipitation and from the melt of an occasional snowfall. Rainwater or snow melt may flow away in surface streams, it may evaporate, or it may seep into the soil to become ground water.

OCCURRENCE, MOVEMENT, AND STORAGE

Ground water occupies interstices or voids in the soils and rocks of the earth's crust. According to their origin, these interstices can be divided into original and secondary. Original interstices are created as a result of the processes by which the rock was formed and secondary interstices are developed by processes that affected the rock after it was formed. Included in secondary interstices are joints, fissures, and solution passages. The size, shape, and arrangement of interstices affect the storage and movement of ground water.

The largest water supplies in the Russellville area occur in solution openings in the Bangor Limestone. The ground-water conditions, occurrence, and availability may vary from place to place. In some parts of the Russellville area, the limestones store and transmit very little water. In other places they are very good aquifers. The important factors controlling the occurrence of ground water in limestone are the original texture and chemical composition of the rock. These factors may in turn determine the extent to which solution passages have been developed.

Water derived from precipitation carries carbon dioxide in solution (carbonic acid). Also, organic acids derived from decaying vegetation may be added to the water as it percolates through the regolith and soil. The slightly acidic water attacks and dissolves the calcareous limestone, thereby enlarging the interstices, or openings, through which it percolates. Under favorable geologic and climatic conditions, an extensive network of solution passages may develop along the secondary fissures, greatly increasing the porosity and permeability of the limestone.

The porosity or percentage of open spaces in a rock determines the amount of water a given rock will hold. The porosity of a sedimentary rock such as sandstone and shale depends on the shape, arrangement and assortment of the constituent particles and the degree of sedimentation and compaction. The porosity of limestone is increased by the voids resulting from the removal of mineral matter through solution by percolating water and by the presence of joint or other fracture openings. A rock is said to be saturated when all its openings, or interstices, are filled with water. The porosity of a rock determines only the amount of water a given rock can hold, not the amount it will yield to a well. Some rocks such as clay may have a high porosity and hold a large amount of water, but will not yield an appreciable amount of water to wells.

The permeability of a rock is its capacity for transmitting water under pressure, and is measured by the rate at which water is transmitted through a unit section under a unit hydraulic gradient. Coarse sand and gravel such as occurs in the Tuscaloosa and regolith, if well sorted, or a very porous limestone with connected openings, are very permeable and will transmit water readily. A

fine-grained sandstone may have a high porosity but because of the size of its openings have a low permeability.

The contour lines on the map in plate 3 were constructed from water-level measurements made in 1961. This map of the Russellville area shows the direction of movement of water and the position of the water table. The water moves from high areas toward lows in the direction of the steepest gradient. Movement is at right angles to the contours. In the central and northern part of the Russellville area, the movement of water conforms to the drainage system along Cedar Creek and its tributaries. In the southern part of the area, the movement of ground water is toward the southeast or southwest, conforming to the natural drainage system.

WATER-TABLE AND ARTESIAN CONDITIONS

The water table is defined as the upper surface of the zone of saturation except where this surface is formed by a bed of clay or other relatively impervious material. The water table is not flat. Its shape, slope, and fluctuations are related to such factors as topography, stratigraphy, and structure of the rocks, rate of withdrawal of water, and variations in rainfall.

Water in wells penetrating solution cavities in the Bangor Limestone generally rises above the point at which it was first encountered. The limestone overlying the solution cavity acts as a confining layer and water in the cavity system is under hydrostatic pressure, caused by the weight of the water at higher levels in the solution cavities affecting an artesian condition. Artesian conditions also occur in the Pottsville Formation and Hartselle Sandstone. Artesian conditions exist at well RTW-7 (table 4). Water-bearing openings were first tapped at 80.5 and 107.5 feet below the land surface. The water level rose from these zones to about 41 feet below the land surface.

WATER-LEVEL FLUCTUATIONS AND THEIR SIGNIFICANCE

Water-level fluctuations in the Russellville area are caused by changes in storage taking place in the ground-water reservoir. The extent of the changes in storage depend on the degree of confinement of the water and the nature of the force causing the

changes. Included in these forces are precipitation, drought, natural discharge, withdrawals by pumping, evapotranspiration, changes in the barometric pressure, and other minor factors. Some forces, such as changes in barometric pressure, earthquakes, and changes in surface loading, have only a temporary effect on the water levels and are indicative of only minor changes in the storage of ground water. Figure 7 shows changes in the water level in well RTW-4 caused by changes in the barometric pressure. An increase in the

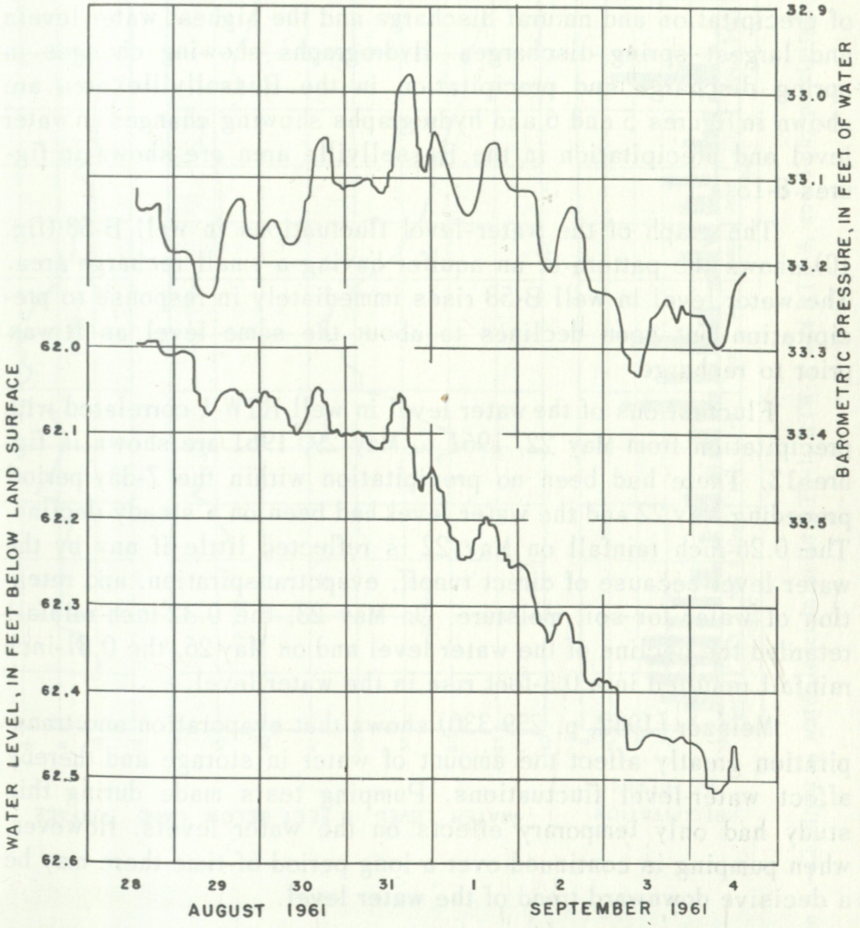

Figure 7.—Changes in water level in well RTW-4 due to changes in barometric pressure

barometric pressure causes a decline in the water level, and a decrease in barometric pressure causes a rise in the water level. The ratio of water-level change to the barometric change, in equivalent units, is termed the barometric efficiency of the well (Wisler and Brater, 1959, p. 141). The barometric efficiency, as expressed in percentage, is about 55 percent in well RTW-4.

The amount of precipitation is related directly to the seasonal fluctuation of the water table and spring discharges in the Russellville area. Normally March and April have the highest amount of precipitation and natural discharge and the highest water levels and largest spring discharges. Hydrographs showing changes in spring discharge and precipitation in the Russellville area are shown in figures 5 and 6 and hydrographs showing changes in water level and precipitation in the Russellville area are shown in figures 8-13.

The graph of the water-level fluctuations in well B-58 (fig. 10) shows the pattern of an aquifer having a small recharge area. The water level in well B-58 rises immediately in response to precipitation but soon declines to about the same level as it was prior to recharge.

Fluctuations of the water level in well RTW-1 correlated with precipitation from May 22, 1961 to May 29, 1961 are shown in figure 13. There had been no precipitation within the 7-day period preceding May 22 and the water level had been on a steady decline. The 0.26-inch rainfall on May 22 is reflected little if any by the water level because of direct runoff, evapotranspiration, and retention of water for soil moisture. On May 23, the 0.32-inch rainfall retarded the decline of the water level and on May 26, the 0.81-inch rainfall resulted in a 0.3-foot rise in the water level.

Meinzer (1942, p. 259-330) shows that evaporation and transpiration greatly affect the amount of water in storage and thereby affect water-level fluctuations. Pumping tests made during this study had only temporary effects on the water levels. However, when pumping is continued over a long period of time there may be a decisive downward trend of the water level.

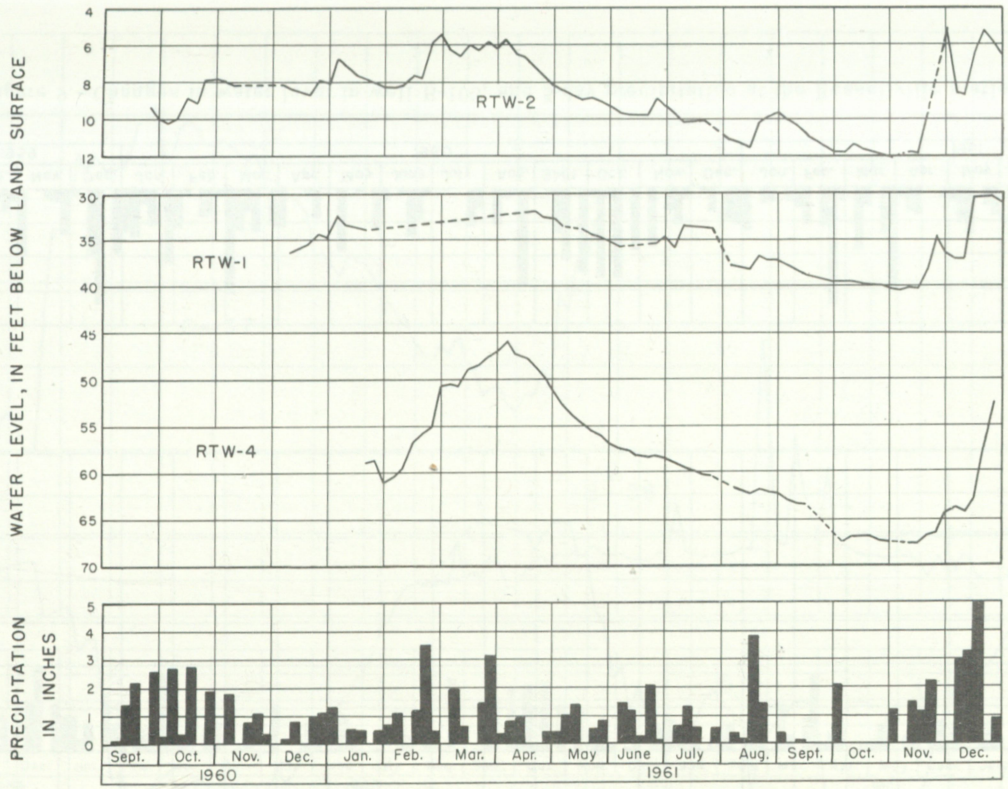

Figure 8.—Changes in water level in wells RTW-1, RTW-2, and RTW-4, and 5-day precipitation at the Russellville station 2.

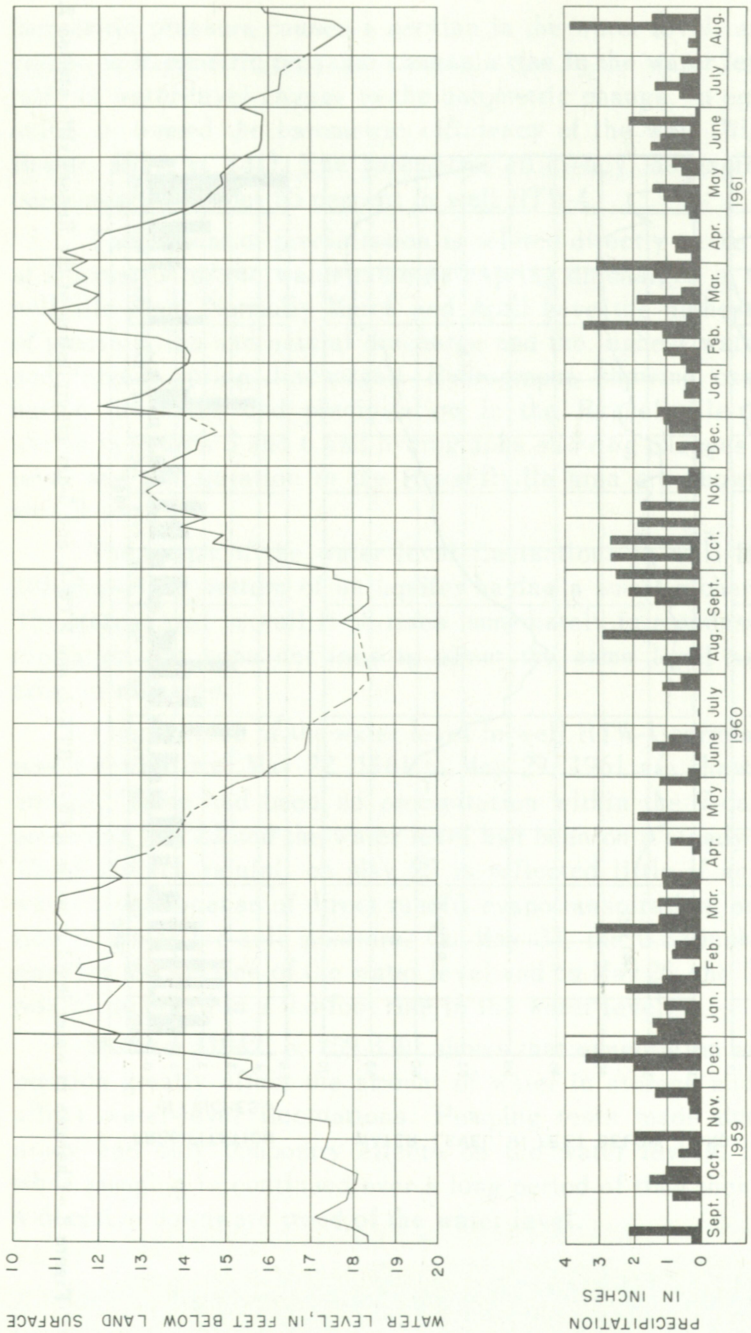

Figure 9.—Changes in water level in well B-108, and 5-day precipitation at the Russellville station 2.

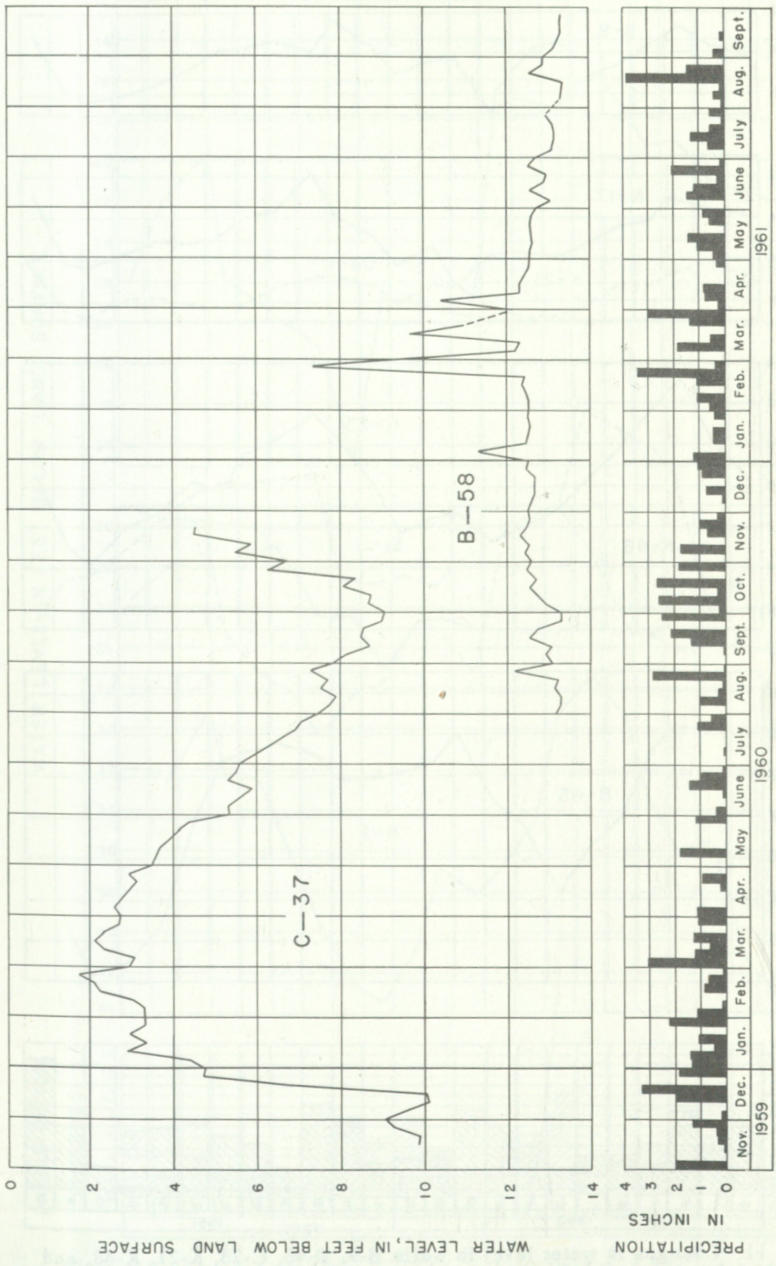

Figure 10.—Changes in water level in wells B-58 and C-37, and 5-day precipitation at the Russellville station 2.

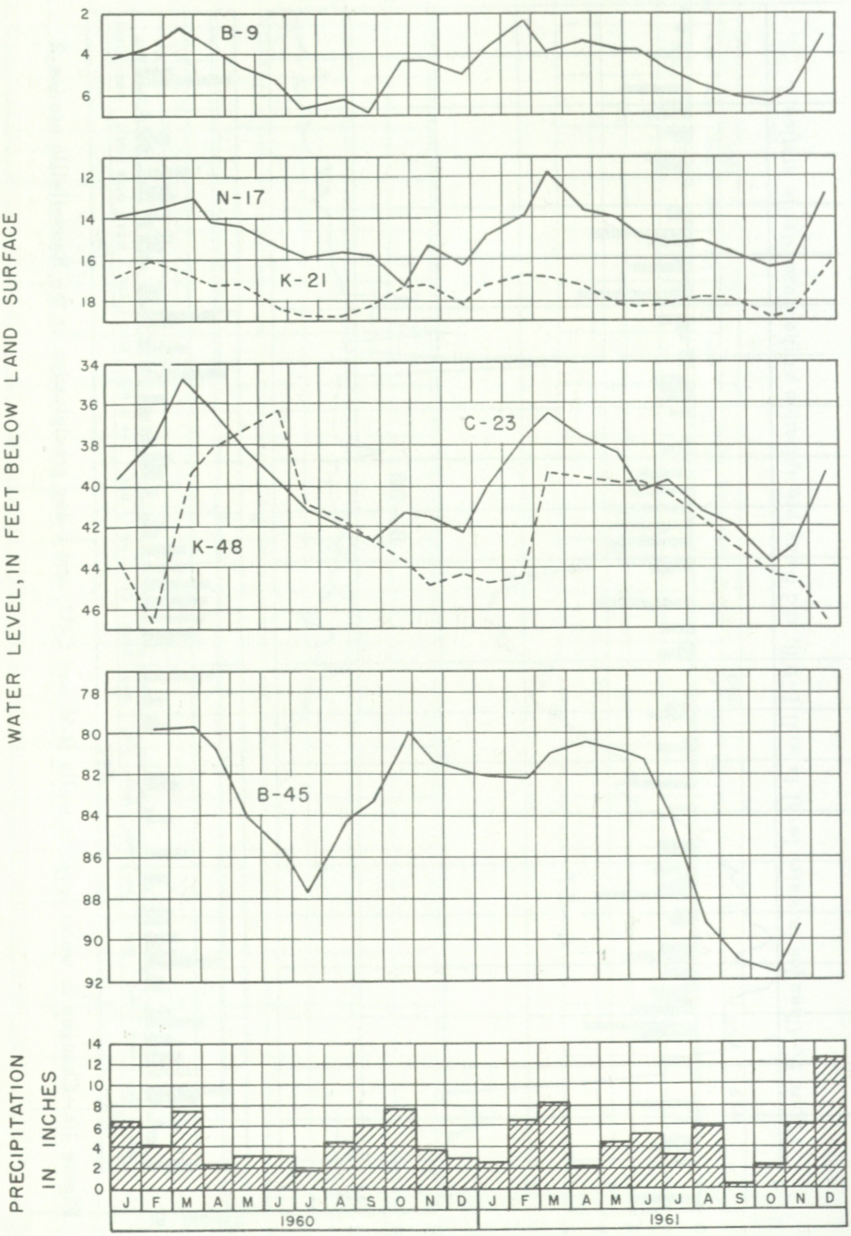

Figure 11.—Changes in water level in wells B-9, B-45, C-23, K-21, K-48, and N-17, and precipitation at the Russellville station 2.

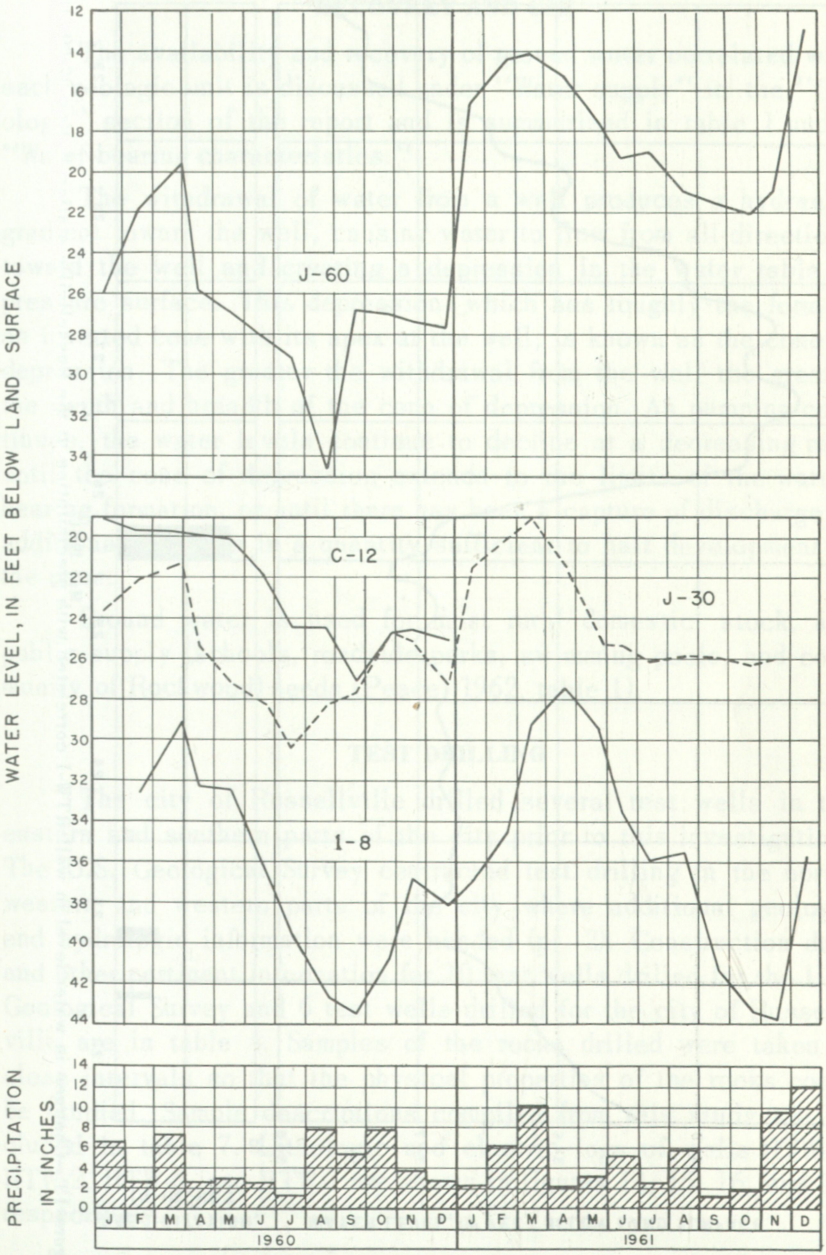

Figure 12.—Changes in water level in wells C-12, I-8, J-30, and J-60, and precipitation at the Belgreen station.

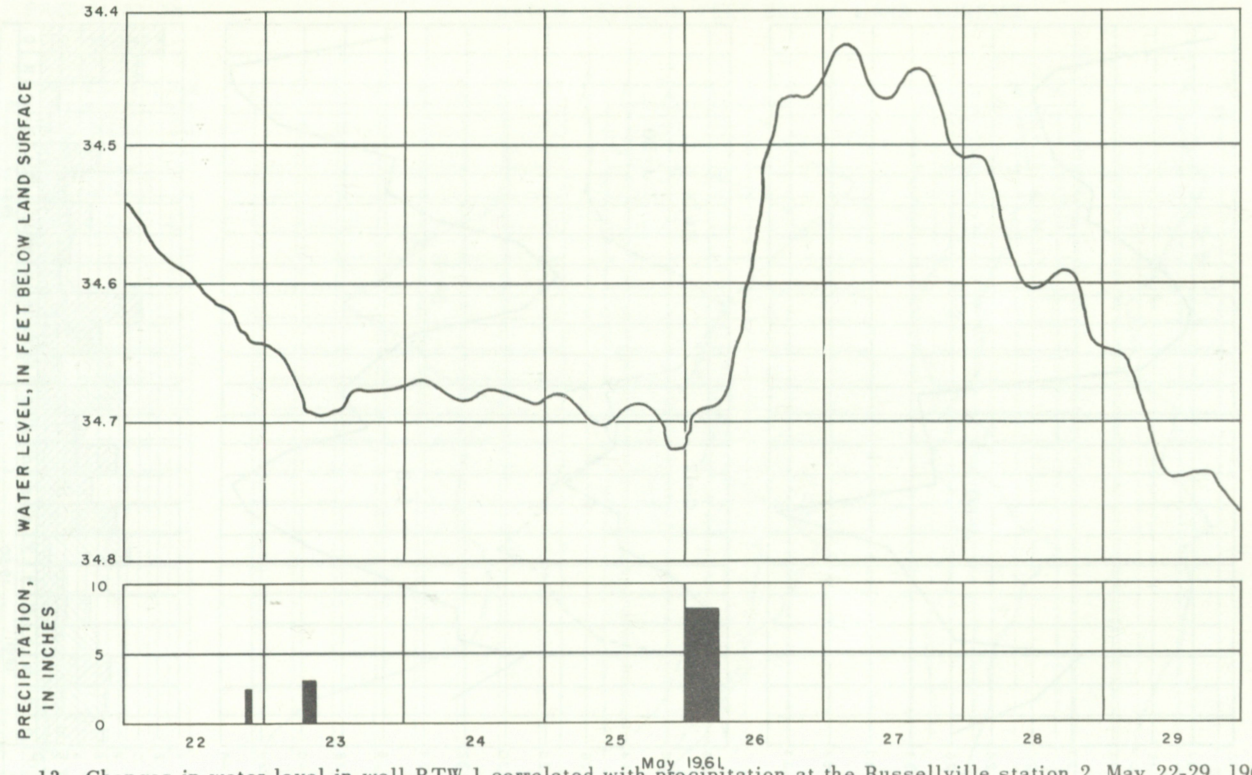

Figure 13.—Changes in water level in well RTW-1 correlated with precipitation at the Russellville station 2, May 22-29, 1961.

RECOVERY AND USE

The availability and recovery of ground water correlated with each geologic unit is discussed under "Water supply" in the "Geology" section of the report and is summarized in table 1 under "Water-bearing characteristics."

The withdrawal of water from a well produces a hydraulic gradient toward the well, causing water to flow from all directions toward the well and creating a depression in the water table or pressure surface. This depression, which has roughly the form of an inverted cone with its apex at the well, is known as the cone of depression. The greater the withdrawal from the well the greater the depth and breadth of the cone of depression. As pumping continues, the water levels continue to decline at a decreasing rate until the cone of depression extends to the limits of the water-bearing formation, or until there has been a capture of discharge or additional recharge in a quantity sufficient to halt development of the cone.

Ground water is used for most rural domestic, stock, and public supply (schools, roadside parks, swimming pools, and community of Rockwood) needs (Peace, 1962, table 1).

TEST DRILLING

The city of Russellville drilled several test wells in the eastern and southern parts of the city prior to this investigation. The U.S. Geological Survey contracted test drilling in the northwestern and western parts of the city where additional geologic and hydrologic information were needed (pl. 2). Construction data and other pertinent information for 10 test wells drilled for the U.S. Geological Survey and 6 test wells drilled for the city of Russellville are in table 4. Samples of the rocks drilled were taken at close intervals so that the physical properties of the rocks could be studied. Sample descriptions compiled from this study are included in table 7. Lithologic and electric logs of wells RTW-1, RTW-2, RTW-6, and RTW-7 are shown in figures 14, 15, 16, and 17, respectively.

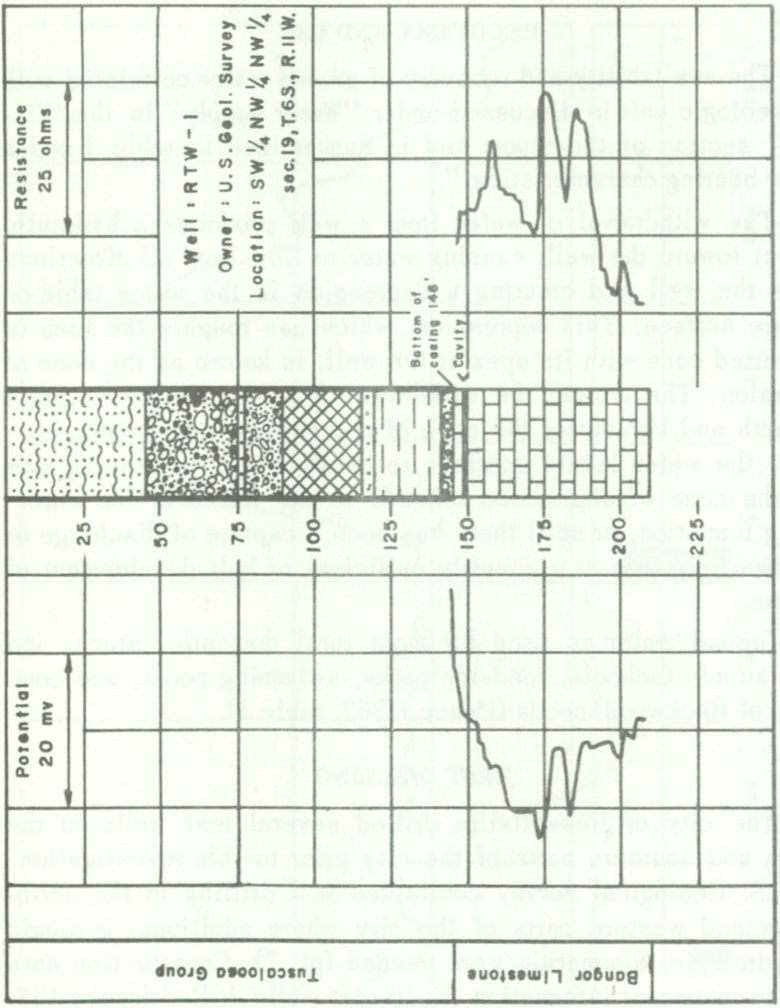

Figure 14.—Lithologic and electric log of well RTW-1.

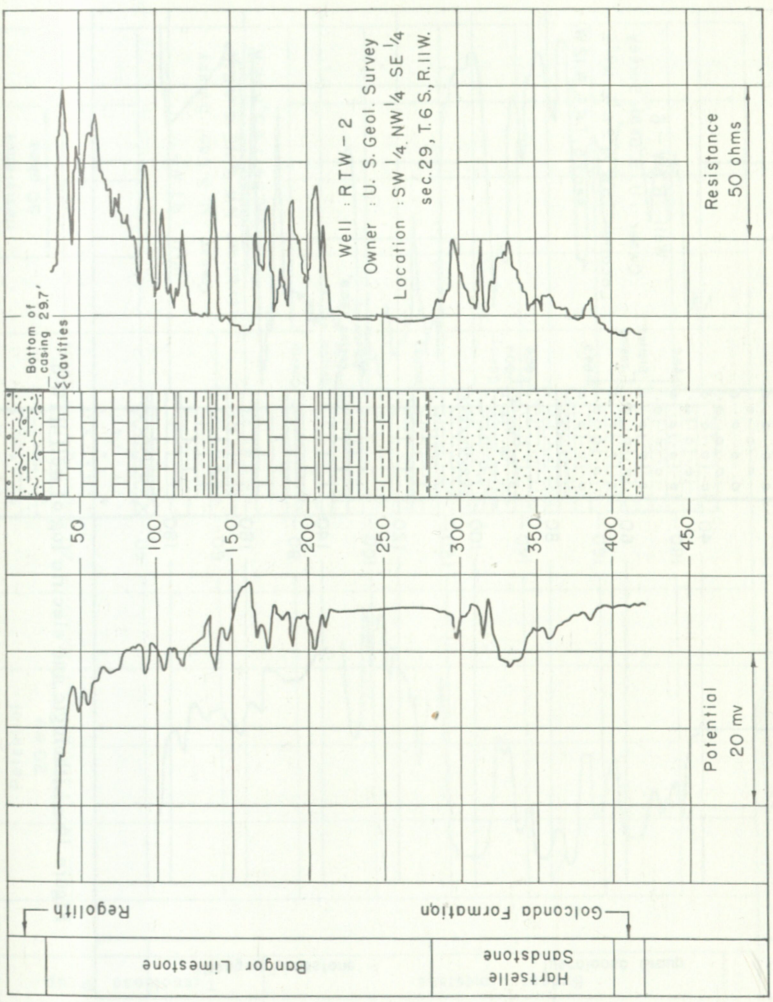

Figure 15.—Lithologic and electric log of well RTW-2.

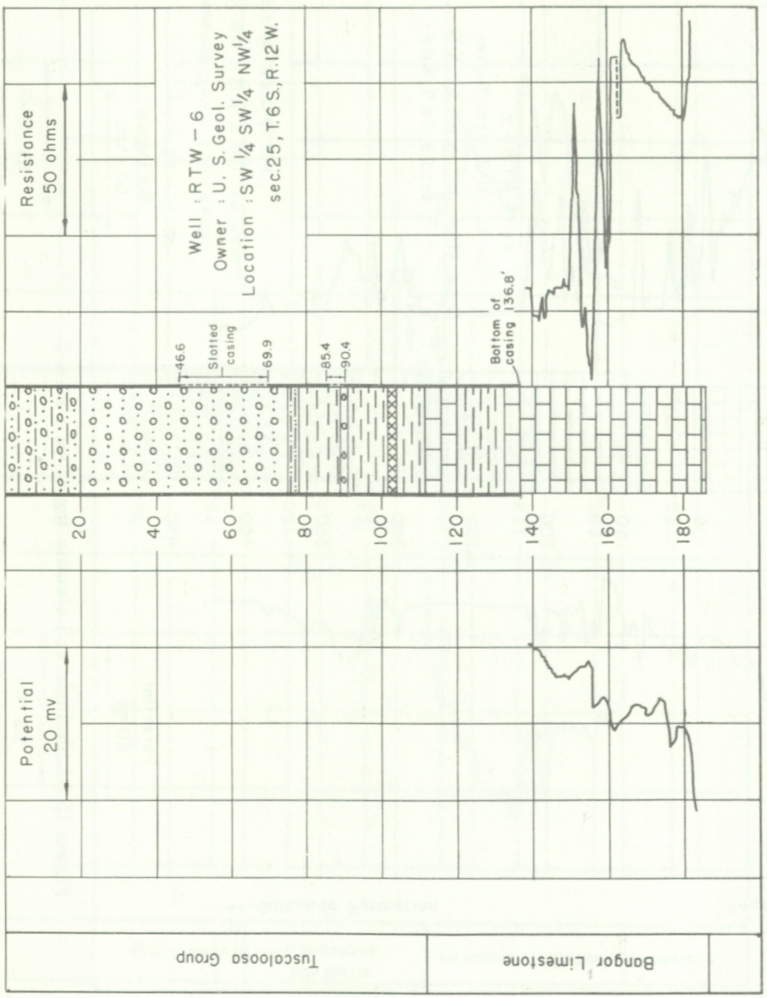

Figure 16.–Lithologic and electric log of well RTW-6.

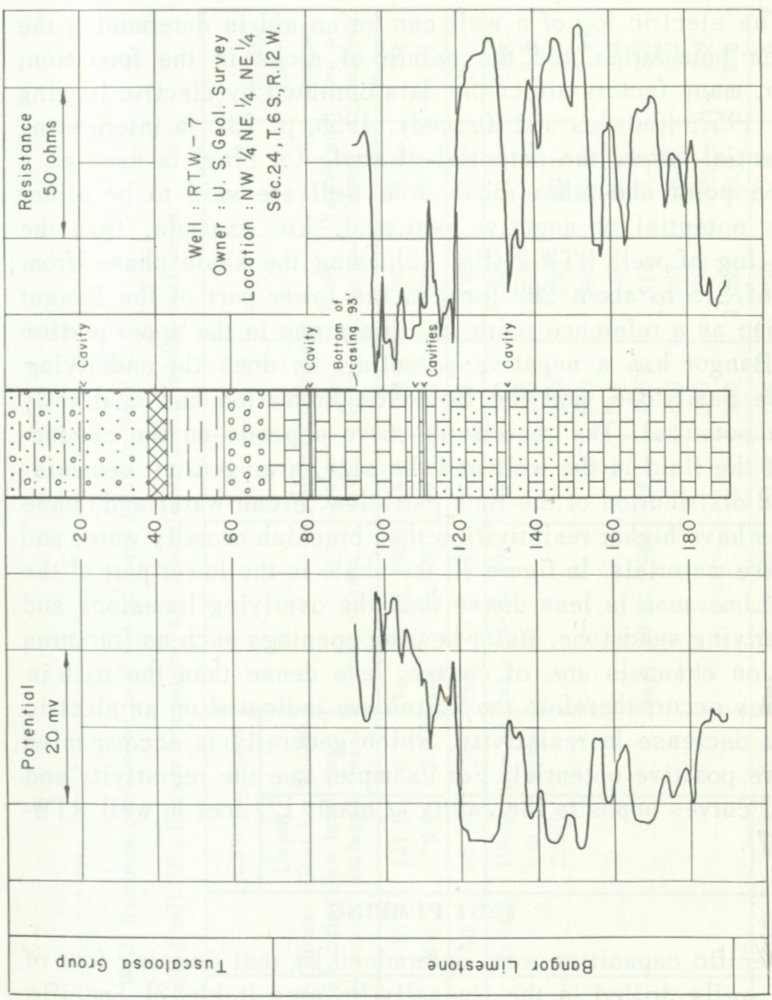

Figure 17.—Lithologic and electric log of well RTW-7.

The electric log of a well can be an aid in determining the formation boundaries and the nature of rocks in the formation; however, many factors affect the data obtained by electric logging (Guyod, 1957; Knowles and Kennedy, 1958, p. 23). In interpreting the potential curve, the potential of shale (or clay) is used as a reference point and other rocks in a well are said to be either positive potential or negative potential. For example, from the electric log of well RTW-2 (fig. 15) using the shale phase (from depths of 215 to about 280 feet) in the lower part of the Bangor Limestone as a reference point, the limestone in the upper portion of the Bangor has a negative potential, as does the underlying Hartselle Sandstone, and the Golconda Formation has a slightly positive potential. The resistivity curve depends on the conductivity of the fluid in the well and the size, arrangement, cementation, and distribution of the rock particles. Fresh water and dense materials have higher resistivities than brackish or salty water and less-dense materials. In figure 15 the shale in the lower part of the Bangor Limestone is less dense than the overlying limestone and the underlying sandstone. Water-bearing openings such as fractures or solution channels are, of course, less dense than the rock in which they occur; therefore they often are indicated on an electric log by a decrease in resistivity, which generally is accompanied by a more positive potential. For example, see the resistivity and potential curves opposite the cavity at about 127 feet in well RTW-7 (fig. 17).

TEST PUMPING

Specific capacities were determined by test pumping four of the test wells drilled in the Russellville area (table 2). Specific capacity is defined as the rate of discharge per unit of drawdown and is expressed in gallons per minute per foot of drawdown.

Test pumping done during this study was either by the uniform rate method or by the step rate method. Wells RTW-1 and RTW-2 were test pumped by the uniform rate method (figs. 22, 23 and table 2). Wells RTW-4 and RTW-7 were test pumped by the

Table 2.—*Test pumping data on U.S. Geological Survey test wells in the Russellville area*

Well: Numbers correspond to those on plate 2 and in table 7.

Water-bearing unit: Mb, Bangor Limestone; Kt, Tuscaloosa Group (undifferentiated).

Well	Location			Depth (feet below land surface)	Water-bearing unit	Cavity system		Date of test	Pretest water level	Pumping rate (gpm)	Time (minutes)	Drawdown (feet)	Specific capacity (gpm per foot of drawdown)
	Section	Township South	Range West			Depth (feet below land surface)	Thickness (feet)						
RTW-1	19	6	11	210	Kt	141.0	0.7	Dec. 13, 1960	35.2	33	197	26.8	1.2
					Mb(?)	170.0	2.0(?)	Aug. 25, 1961	36.3	33	334	30.2	1.1
RTW-2	29	6	11	420	Mb	36, 42	.5	Nov. 3, 1960	7.6	37.5	183	.8	47
RTW-4	26	6	12	238	Kt-Mb	100.0 to 228.0	Broken zone	Jan. 24-26, 1961	59.0	119	360	11.1	10.7
										240	1,220	27.9	8.6
										350	280	39.0	9.0
										240	960	30.2	7.9
										119	60	20.5	5.8
								Sept. 20-22, 1961	64.5	100	413	17.3	5.8
										150	657	18.2	8.2
										200	755	25.3	7.9
										300	1,055	35,0	8.6
RTW-7	24	6	12	191	Kt(?)	80.5	0.5	Oct. 17-19, 1961	41.1	100	960	27.4	3.6
					Mb	107.5	2.0			200	1,411	47.2	4.3
						110.5	.8			100	394	27.6	3.6
						132.0	1.0						

step rate method (figs. 18, 19, 21, and table 2), which, as the name implies, involves changing the rate of pumping. The step rate method may be used during both the drawdown and recovery stages of the test, or it may be used during only one stage. Ideally, increases or decreases in the rate of pumping are made after the pumping water level becomes almost stationary.

Two step tests were conducted on well RTW-4 (figs. 18, 19). The specific capacities ranged from 5.8 to 10.7 (table 2). These tests indicate that the pumpage during the test conducted in January 1961 dewatered the upper sand and gravel beds in the Tuscaloosa Group. Thus a high but inaccurate specific capacity of 10.7 was indicated during the first step when the discharge was 119 gpm (fig. 20). For the last step during the recovery stage the discharge was again 119 gpm and the upper sand and gravel beds, then dewatered, had a specific capacity of 5.8. The second step test was conducted on the well during the season of low water levels, September 1961, when the upper sand and gravel were normally dewatered and the specific capacity was 5.8 at discharge rate of 100 gpm, corresponding to the 5.8 derived from the last step of the recovery stage of the January 1961 test.

A step test was conducted on RTW-7 October 17-19, 1961 (fig. 21). The specific capacity was 3.6 at a discharge rate of 100 gpm for the drawdown stage of the test, rose to 4.3 as the discharge rate was increased to 200 gpm, and then returned to 3.6 as the discharge rate was decreased to 100 gpm during the recovery stage (table 2). The specific capacities are the same (3.6) at 100 gpm for both the drawdown and the recovery stages. This indicates that the upper sand and gravel is dewatered during the season of low water levels. The varied specific capacities of test wells RTW-4 and RTW-7 are primarily due to incomplete development of the aquifer.

Test pumping was done on wells RTW-1 and RTW-2 for periods of short duration and at small rates of discharge. The specific capacity of 47 for well RTW-2 is not indicative of specific capacities of other wells in the area and is thought to be due in part to infiltration from a creek in the recharge area. Data from the three tests on the two wells are shown in figures 22 and 23 and table 2.

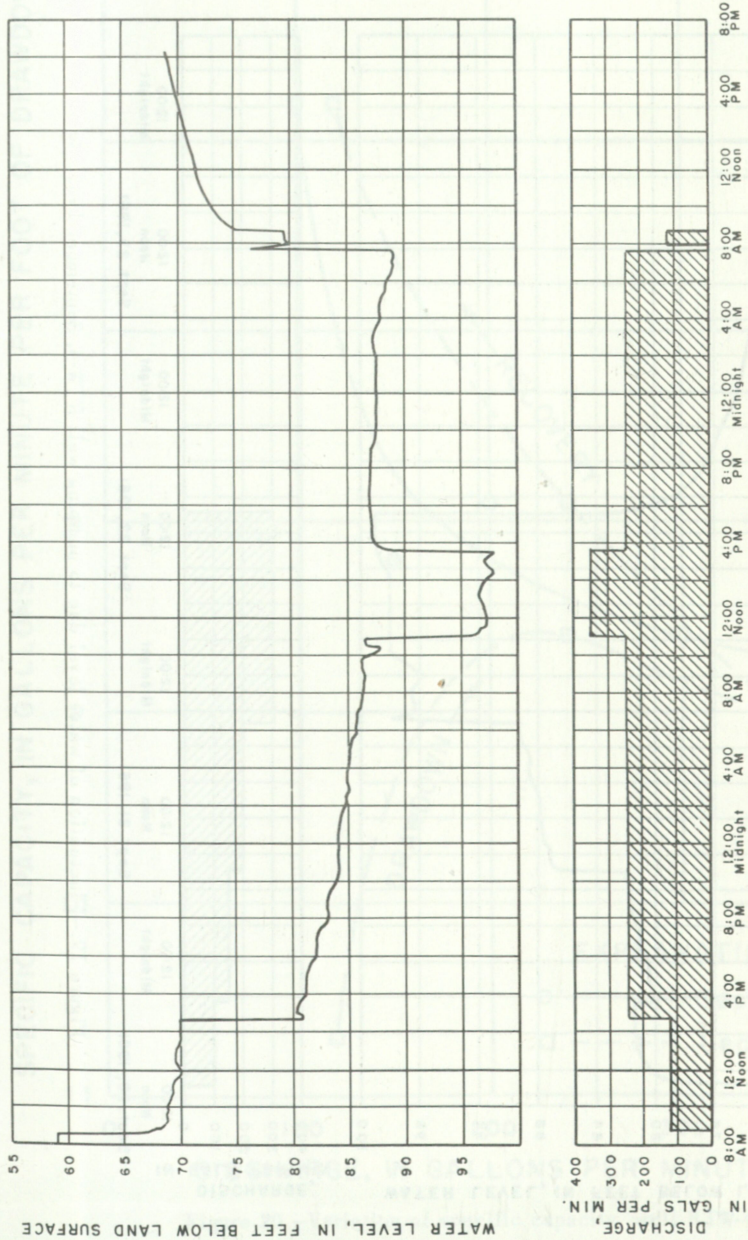

Figure 18.—Fluctuation of water level due to pumping well RTW-4, January 1961.

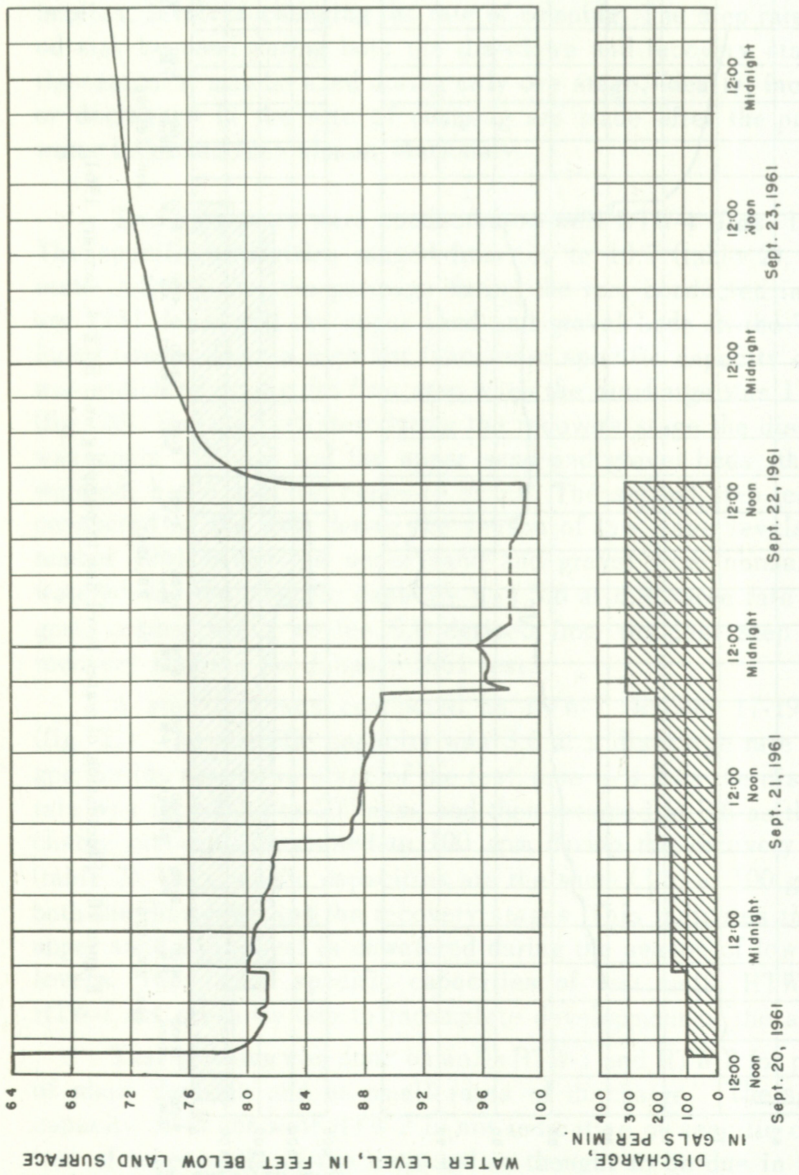

Figure 19.—Fluctuation of water level due to pumping well RTW-4, September 1961.

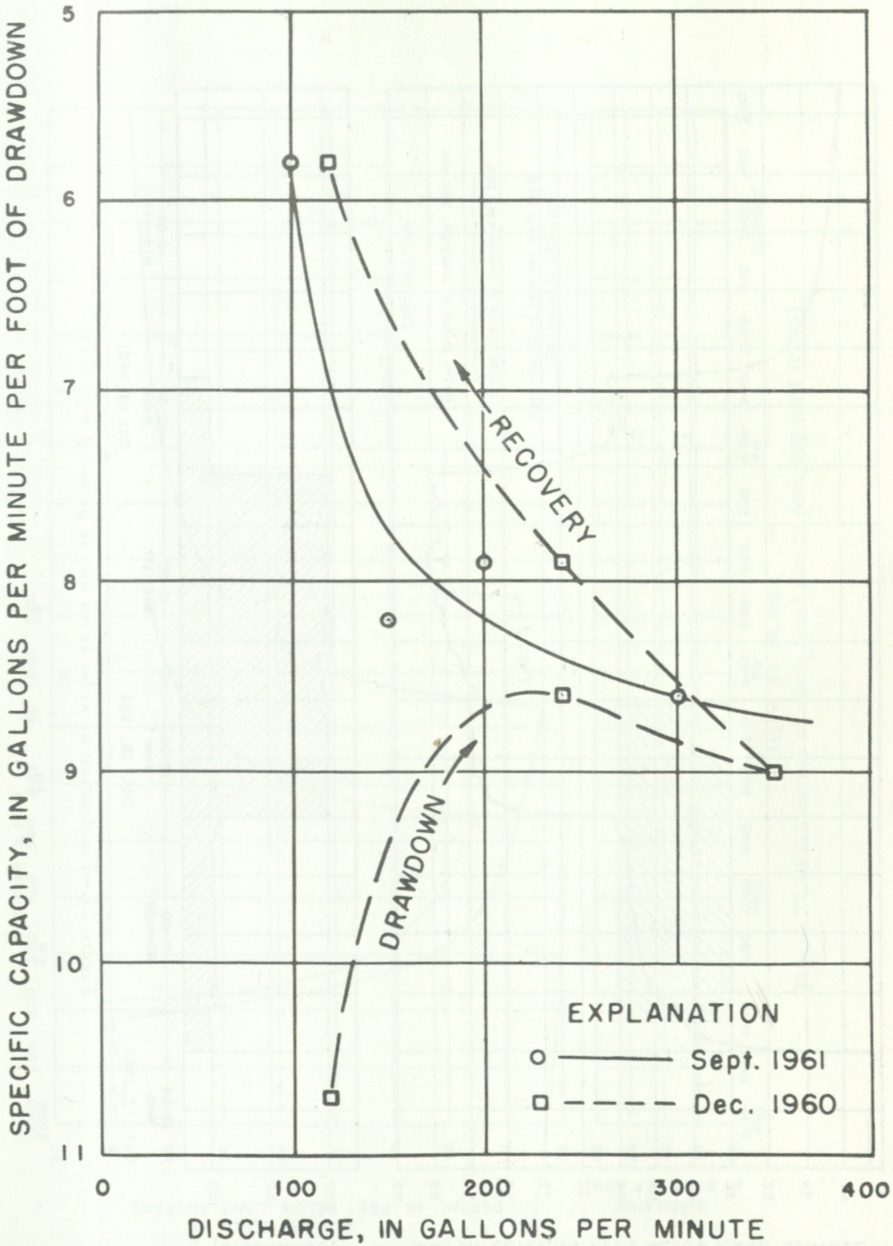

Figure 20.—Variation of specific capacity, well RTW-4.

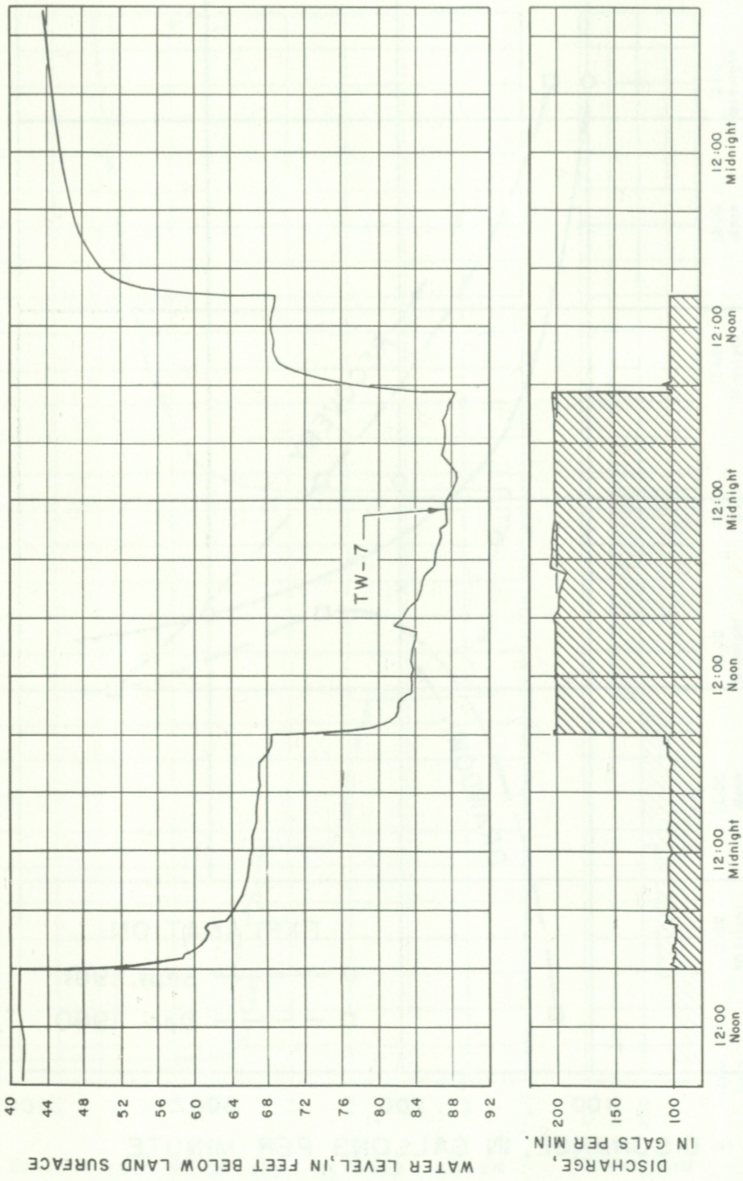

Figure 21.—Fluctuation of water level due to pumping well RTW-7.

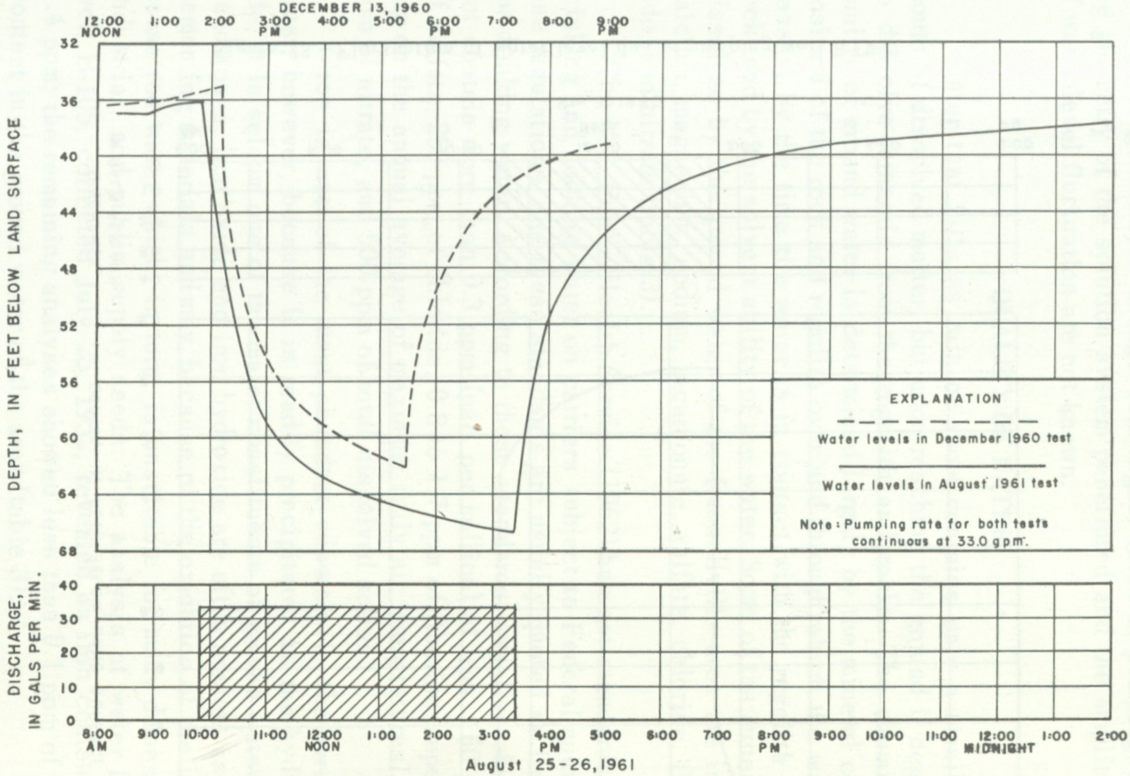

Figure 22.—Fluctuation of water level due to pumping well RTW-1.

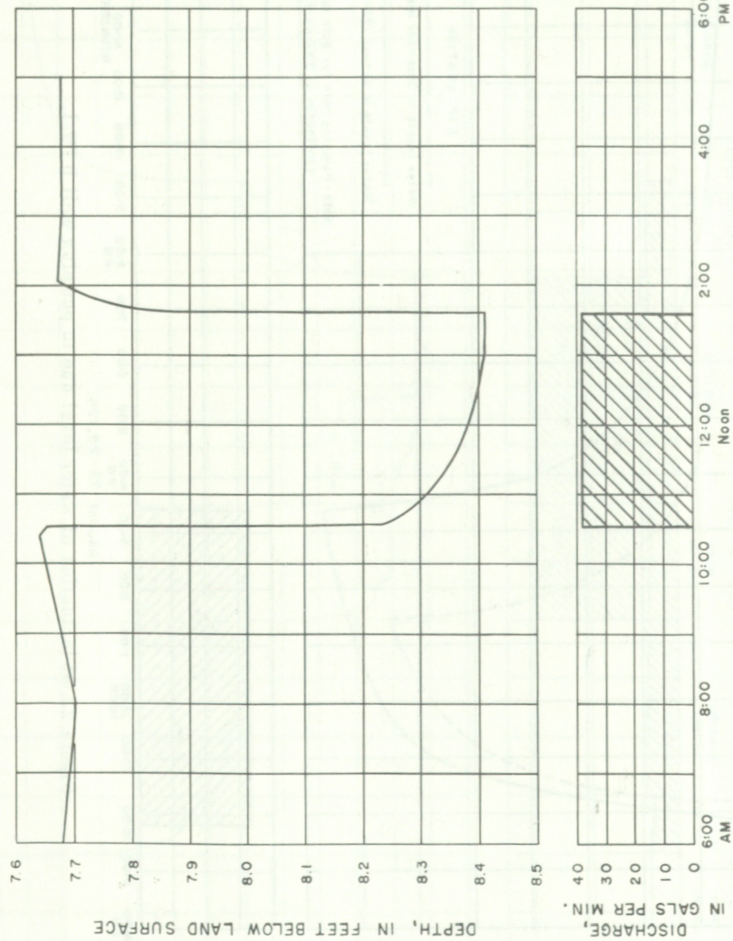

Figure 23.—Fluctuation of water level due to pumping well RTW-2.

The specific capacity should be used with caution, however, as there is generally a change with higher rates of pumping, and the geometry of the solution system penetrated and the amplitude of water-level fluctuation are not known.

QUALITY OF WATER

Water that falls as rain or snow contains only a small amount of dissolved matter, but upon reaching the ground it begins to dissolve minerals from the regolith and rocks. The chemical quality of ground water is determined largely by the mineral composition of the rock and regolith over and through which the water passes, by the time the water is in contact with the regolith and rock, and by the solvent ability of the water. Some of the minerals dissolved by the ground water of the Russellville area are iron, calcium, magnesium, sodium, bicarbonate, sulfate, chloride, fluoride, and nitrate (table 3).

The U.S. Public Health Service (1962) has set standards for drinking and cooking water on carriers subject to Federal quarantine regulations, and these standards are usually quoted as limits for drinking water. According to these standards, supplies should not contain more than 0.3 ppm (part per million) of iron, 250 ppm of sulfate, 250 ppm of chloride, 0.8 to 1.7 ppm of fluoride (depending on the annual average of maximum daily air temperatures), 45 ppm of nitrate, and 500 ppm of total dissolved solids.

Iron is one of the most abundant minerals in the earth's crust; however, because it is readily precipitated as the hydroxide, it is seldom one of the major constituents of ground water. In sandstones, iron oxide and iron hydroxide are often present as the cementing materials and may, because of the oxidation of the iron, cause red water which, in turn, is unsuitable for many domestic, industrial, and public supply needs. The analysis of water from well B-105, collected July 25, 1952, revealed an iron content of 1.4 ppm; the remaining analyses showed less than 0.1 ppm of iron content in the ground water of the area (table 3).

Table 3.—*Chemical analyses of water from selected wells and springs in the Russellville area*

Well or spring: numbers correspond to those on plate 2 and in tables 4 and 6.

Method of sampling: B, bailer; P, pump; S, spring.

Water-bearing unit: Mh, Hartselle Sandstone; Mb, Bangor Limestone; Kt, Tuscaloosa Group (undifferentiated). Hyphenated symbols indicate well produces water from both formations or at or near the contact.

Well or spring	Location			Date of collection	Water-bearing unit	Depth of well (feet)	Method of sampling	Temperature (°F)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Hardness as $CaCO_3$		Specific conductance (micromhos at 25° C)	pH
	Section	Township South	Range West														Calcium, magnesium	Noncarbonate		
									Parts per million											
B-9	3	6	11	6- 7-60	Mb	61.7	B	60	236	136	206	248	1,012	150	0.2	0.0	1,150	772	2,720	8.1
B-9	3	6	11	2- 1-61	Mb	61.7	B	60	264	168	154	492	1,060	132	.4	.4	1,350	...	2,660	7.9
B-17	5	6	11	5- 7-60	Mb	52.9	P	...	75	11	11	290	4.0	8.0	.2	5.4	232	0	461	8.2
B-34	11	6	11	2- 1-61	Mh	204.4	P	...	12	6.3	178	458	16	38	1.5	.3	56	...	829	8.1
[1]B-45	14	6	11	6- 5-60	Mh	153.0	B	62	12	3.6	680	836	532	30	7.1	8.3	45	0	2,690	8.4
[2]B-45	14	6	11	2- 1-61	Mh	153.0	B	61	11	14	1,120	1,230	1,260	55	12	2.5	85	...	4,412	8.4
B-60	20	6	11	6- 6-60	Mb	120	P	...	73	9.7	5.1	272	10	1.0	.2	.1	222	0	434	8.1
[3]B-105	29	6	11	7-25-52	Mb	157	P	61.5	59.7	4.7	2.5	58.6	13.0	7.1	....	....	175.1	...	.....	7.0
B-108	29	6	11	6- 8-60	Mb	62.9	B	61	78	3.3	6.6	236	11	9.0	.1	4.6	210	16	419	7.7
B-125	33	6	11	6- 7-60	Kt	.....	S	60	8.6	.9	2.4	27	1.6	3.0	.0	6.1	25	3	67	7.0
B-125	33	6	11	2- 2-61	Kt	.....	S	60	8.6	1.1	2.5	27	1.2	4.0	.1	5.0	26	...	69	6.5
C-1	2	6	12	6- 8-60	Kt	74.3	B	64	20	2.2	8.5	53	.4	12	.0	24	59	16	168	7.4
C-12	6	6	12	6- 8-60	Mb	72.0	B	61	51	35	10	296	19	22	.1	.1	271	28	539	8.1
C-37	26	6	12	6- 8-60	Kt	65.5	B	58	1.8	2.8	.4	22	.4	1.2	.0	.1	16	0	42	7.0
[4]I-5	10	7	12	8- 8-29	Mb	80	S	61.6	56	5.4	.9	190	4.9	1.6	....	1.3	162	...	.....	...
I-8	14	7	13	6- 7-60	Kt	80.5	P	62	20	.5	3.4	59	.8	3.5	.0	11	52	4	129	6.9
J-11	12	7	12	6- 8-60	Mb	67.5	B	63	83	5.1	4.7	250	14	7.0	.1	11	228	23	450	8.1

RTW-1	19	6	11	2- 1-61	Kt Mb(?)	210.0	B	61	14	1.2	5.4	50	5.2	5.5	.2	.1	40	...	106	7.4
[5]RTW-1	19	6	11	9-22-61	Kt Mb(?)	210.0	B	60	29	2.4	3.4	96	.0	7.0	.1	.0	82	3	162	7.0
RTW-1	19	6	11	1- 2-62	Kt Mb(?)	210.0	B	...	14	2.0	3.0	56	.0	3.0	.1	....	43	...	101	7.0
RTW-2	29	6	11	2- 1-61	Mb	420.0	B	60	83	3.6	6.6	252	7.6	10	.1	5.4	222	...	443	7.5
RTW-4	26	6	12	1-26-61	Kt-Mb	238.0	P	60	46	2.2	.8	148	1.2	2.0	.1	.6	124	...	236	8.0
[6]RTW-4	26	6	12	9-22-61	Kt-Mb	238.0	P	61	46	3.7	.9	159	.0	1.1	.1	.0	130	0	244	7.1
RTW-4	26	6	12	2- 2-62	Kt-Mb	238.0	B	60.5	3.0	.1	.9	10	.0	1.0	.1	....	8	...	22	6.2
RTW-5	26	6	12	2- 2-62	Kt-Mb	113.0	B	60	11	2.6	2.3	48	.0	2.0	.1	....	38	...	91	6.8
RTW-6	25	6	12	2- 2-62	Kt	186.5	B	58.5	3.1	.5	2.3	16	.0	1.0	.1	....	10	...	35	6.2
RTW-7	24	6	12	2- 2-62	Mb Kt(?)	191.0	B	60	23	1.1	5.5	85	.0	3.0	.1	....	62	...	143	7.4

[1]Carbonate (CO_3): 32 ppm.
[2]Carbonate (CO_3): 24 ppm.
[3]Analysis by Southern Testing Laboratories, Inc. Includes silica (SiO_2), 14.4 ppm; iron (Fe), 1.4 ppm; dissolved solids, 114.0 ppm.
[4]From Johnston, 1933, pt. 1, p. 218. Includes silica (SiO_2), 13 ppm; iron (Fe), 0.10 ppm; potassium (K), 0.9 ppm; total dissolved solids, 180 ppm.
[5]Silica (SiO_2), 0.8 ppm; potassium (K), 0.4 ppm; color, 10; dissolved solids, calculated sum = 91 ppm, residue at 180° C = 97 ppm, tons per acre ft = 0.13 ppm.
[6]Silica (SiO_2), 6.3 ppm; potassium (K), 0.3 ppm; color, 10; dissolved solids, calculated sum = 136 ppm, residue at 180° C = 140 ppm, tons per acre ft = 0.19 ppm.

Hardness of water is the property attributable to the presence of the two principal alkaline earths, calcium and magnesium. Calcium and magnesium are dissolved from most of the rocks through which ground water passes. However, they are usually found in larger quantities in water that has percolated through limestones and dolomites. For example, water in well B-9 is from limestone and the two samples collected have a calcium content of 236 and 264 ppm and a magnesium content of 136 and 168 ppm, whereas water in well B-34 is from sandstone and has a calcium content of 12 ppm and a magnesium content of 6.3 ppm (table 3). Hardness causes scum in bathtubs, gray laundry, scale in hot water tanks, lines, and boilers, excessive soap consumption, and other problems. However, a high ratio of calcium and magnesium to sodium is desirable in irrigation water because they flocculate the soil colloids and tend to maintain good soil structure and permeability. In this report the numerical ranges of calcium and magnesium hardness (in parts per million) and their equivalent adjective ratings for water hardness are as follows:

Hardness range (ppm)	Classification
0-60	Soft
61-120	Moderately hard
121-180	Hard
181 or more	Very hard

Hardness of the water sampled ranges from soft to very hard. Both field determinations (Peace, 1962 and 1963) and laboratory determinations (table 3) are included in the summary of hardness data below.

	Number of samples	Hardness		
		Minimum	Maximum	Median
Regolith	23	10	815	206
Tuscaloosa Group	71	10	320	92
Pottsville Formation	9	20	86	50
Bangor Limestone	123	8	1,350	204
Hartselle Sandstone	24	12	440	62

Sodium makes up only a small part of the dissolved mineral content in ground water and in small or moderate amounts has little or no effect on the suitability of water for domestic or industrial uses. The high sodium content (680 and 1,120 ppm) in the water from well B-45 (table 3) may be partially the reason the owner does not use the water (table 6).

Carbonate was present only in the two water samples taken from well B-45 (sample taken 6-6-60, 32 ppm; sample taken 2-1-61, 24 ppm). The well is developed in the Hartselle Sandstone; however, well B-34 is also developed in the Hartselle and no carbonate was reported in water from this well. Bicarbonate was reported in each of the 27 analyses in table 3 in concentrations ranging from 10 to 1,230 ppm.

Sulfate is dissolved from most sedimentary rocks and large quantities may be derived from some types of shale. The sulfate content in ground water from two wells (B-9 and B-45) in the Russellville area was higher than the U.S. Public Health Service recommendation; two samples from well B-9 had 1,012 ppm and 1,060 ppm and two samples from well B-45 had 532 ppm and 1,260 ppm (table 3). Both these wells are finished in the lower shaly part of the Bangor Limestone, which is probably the source of the sulfate.

Chloride that occurs naturally is very soluble and in ground water it ranges from less than 1 ppm to many thousand parts per million in some brines. A high concentration of chloride imparts a salty taste to the water and is troublesome in water used for irrigation. In the Russellville area the chloride content of ground water is low. Both field determinations (Peace, 1962 and 1963) and laboratory determinations (table 3) are included in the summary of chloride data below.

	Number of samples	Chloride		
		Minimum	Maximum	Median
Regolith	23	11	255	18
Tuscaloosa Group	71	1	117	18
Pottsville Formation	9	4	18	11
Bangor Limestone	123	1	195	18
Hartselle Sandstone	24	4	125	22

Fluoride is sparingly soluble from fluoride-bearing minerals in rocks and is generally present in ground water in only small amounts. Water containing 1.5 ppm or more of fluoride may cause mottling of the enamel of children's teeth if continuously used during the calcification of the teeth (Dean, 1936). Water containing 0.88 to 1.5 ppm of fluoride reduces tooth decay during the same period (Rainwater and Thatcher, 1960). Only three samples of ground water from the Russellville area contained fluoride within or in excess of the U.S. Public Health Service recommendation. Water from well B-45 had a fluoride content of 7.1 ppm on June 6, 1960, and 12 ppm on February 1, 1961; water from well B-34 had a fluoride content of 1.5 ppm (table 3).

Nitrate in ground water is generally attributed to the oxidation of nitrogen of the air by bacteria and to the decomposition of organic material in the regolith; however, it may be added directly to a water resource by fertilizer. In unpolluted water the nitrate concentration seldom exceeds 10 ppm. Water containing high amounts of nitrate can cause infant cyanosis, the so-called "blue baby" disease (Maxcy, 1950, p. 265).

The following is a range, in parts per million, of some of the chemical constituents in ground water from the Bangor Limestone and Tuscaloosa Group in the Russellville area, as reported in table 3:

	Bangor Limestone (11 samples)			Tuscaloosa Group (9 samples)		
	Min.	Max.	Median	Min.	Max.	Median
Calcium	23	264	73	1.8	9	14
Magnesium	1.1	168	5.4	.5	2.8	1.2
Sodium	.9	206	6.6	.4	8.5	3.0
Bicarbonate	58.6	492	250	16	96	50
Sulfate	.0	1,060	10	0	5.2	.4
Chloride	1.0	150	8.0	1.0	12	3.5
Fluoride	.1	.4	.1	.0	.2	.1
Nitrate	.0	11	1.3	.0	24	5.0
Calcium, magnesium hardness	62	1,350	222	10	82	40

The specific conductance is a measure of the ability of the water to carry an electric current and is expressed in mhos or micromhos. Because conductance varies with temperature, the specific conductance is generally computed in an environment where the temperature is 25° C. The specific conductance can be used in the following relationship to determine the dissolved solids:

Specific conductance × 0.65 ± 0.1 = dissolved solids. Using the above computation, water from wells B-9, B-34, and B-45 contained dissolved solids in excess of 500 ppm.

The pH of a water sample is a measure of the hydrogen-ion activity and is expressed by a number denoting the negative logarithm of the concentration of the hydrogen ions. The pH numbers range from 0 to 14. The number 7.0 indicates neutrality, a pH progressively less than 7.0 denotes increasing acidity, and a pH progressively greater than 7.0 denotes increasing alkalinity. The pH of a water indicates its corrosive activity on metal surfaces. As the pH increases, the corrosive activity of water normally decreases; however, excessively alkaline waters are corrosive to some metals, particularly zinc.

The median pH of ground water from the Bangor Limestone is 7.9 and from the Tuscaloosa Group is 7.0.

Conditions for sampling apparently affect the chemical analyses. For example, well RTW-4 was sampled three times (table 3). The first (January 26, 1961) and second (September 22, 1961) samples were taken during pumping tests when water was being withdrawn from the aquifer at more than 100 gpm (table 2). The third sample (February 2, 1962) was withdrawn from within the well casing proper by means of a bailer from about a 60-foot depth below the land surface; the well had not been pumped since the pumping test in September 1961. The calcium, magnesium, bicarbonate, hardness, specific conductance, and pH characteristics show a marked change in the third sample. The third sample has been subjected to change with the passage of time and the environment of the water, and is not representative of the ground water in the aquifer. Water samples used in quality-of-water study were withdrawn from wells either by pumps or by a bailer. The means of withdrawal for each sample is given in table 3.

SUMMARY AND CONCLUSIONS

Ground water is used for most of the water needs in the rural part of the Russellville area and occurs in sandstone, limestone, gravel, and regolith units that underlie the area. The Hartselle Sandstone of Mississippian age is the oldest geologic unit exposed and ranges in thickness from 120 to 328 feet. It crops out in the extreme northern part of the area, where the maximum exposed thickness is about 50 feet. Wells generally yield less than 2 gpm of soft to moderately hard water from the Hartselle. The Bangor Limestone of Mississippian age is exposed in much of the central and northern parts of the area and ranges in thickness from 0 to 445 feet. The basal beds are shaly and fossiliferous, including *Pentremites brevis*, *P. pyramidatus*, and *Prismopora serrulata*, which are diagnostic of the Glen Dean Limestone in other states. Many small water supplies are developed in the Bangor, but most of them yield very hard water. In the central and western parts of the area where the Bangor is covered by sediments of Cretaceous age, wells could be developed that would yield 300 gpm or more. The NE¼SE¼ sec. 26, T. 6 S., R. 12 W., is in an area where large supplies of ground water could be developed for municipal use. The Pennington Formation of Mississippian age crops out in the base of an escarpment running eastward from sec. 27, T. 7 S., R. 12 W.; it consists of about 60 to 100 feet of shale interbedded with crinoidal limestone. The Pennington is not an aquifer in the Russellville area.

The Pottsville Formation of Pennsylvanian age consists of about 180 feet of alternating beds of shale and sandstone. It underlies and is exposed in much of the southern part of the area. Many supplies of soft water are developed from the formation.

The Tuscaloosa Group of Cretaceous age covers all the ridges and hills in the area except in the southeastern part. In some places where the Tuscaloosa overlies the Bangor there are commercial deposits of brown iron ore (limonite). The average thickness of the Tuscaloosa is 88 feet; however, the thickness can vary greatly within relatively short distances because of the irregular pre-Cretaceous erosion surface. The sand and gravel beds of the Tuscaloosa yield small to moderate supplies for farm and domestic use to many wells and springs, but many of these wells

are inadequate in dry seasons. In some places, the Tuscaloosa constitutes a thick permeable reservoir from which ground water can move into the underlying Bangor Limestone. One test well (RTW-4), which obtains part of its water from the Tuscaloosa and part from the Bangor, was pumped at 350 gpm. The quality of water from the Tuscaloosa is generally good; the mineral content is low and the water is moderately hard.

The regolith is of Recent age and is restricted to the residual soil, slope wash, alluvium, and terrace gravel derived from all the other rock units in the area except the Tuscaloosa Group. The thickness of the regolith ranges from 0 to 40 feet. Numerous wells supplied by the regolith yield small amounts of water, though many of the wells are dry during drought. One spring (J-41) issuing from the regolith, and measured periodically, had a minimum flow of 15 gpm. Water from the regolith is generally very hard.

Along the western boundary of the city of Russellville, nine test wells were drilled. Each was started in the Tuscaloosa and eight penetrated the lower shale bed in the Bangor. One well, RTW-2, was drilled in the eastern part of the city, where it penetrated the entire thickness of the Hartselle, stopping in the Golconda Formation. Four of the test wells were pumped, and results indicate that the Bangor and (or) Tuscaloosa will at some places yield more than 500 gpm. Data obtained during drilling showed that the water supply in the other six test wells ranged from 0 to 12 gpm.

The chemical quality of ground water in the Russellville area is generally good and is within standards set by the U.S. Public Health Service. Locally, the content of sulfate, fluoride, or dissolved solids may be high.

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BASIC DATA

Table 4.—*Records of test wells in the Russellville area*

Well: Numbers correspond to those on plate 2; asterisk indicates chemical analysis given in table 3.

Type: D, drilled.

Depth of well and water level: Depths shown in feet are reported; those shown in feet and tenths are measured.

Altitude of land surface: Interpolated from topographic quadrangle maps.

Method of lift: N, none.

Use of water: N, none.

Water-bearing unit: Mb, Bangor Limestone; Kt, Tuscaloosa Group (undifferentiated); N, dry hole. Hyphenated double symbols, such as Kt-Mb, indicates the well produces water from both formations or produces water at or near the contact between the two formations.

Well	Owner	Driller	Type	Depth of well (feet)	Diameter of well (inches)	Water-bearing unit	Altitude of land surface (feet)	Water level		Method of lift	Use of water	Field determinations			Remarks
								Above (+) or below land surface (feet)	Date of measurement			Temperature (°F)	Chloride (Cl) (ppm)	Hardness as $CaCO_3$ (ppm)	
*RTW-1	U.S. Geological Survey.	Hawley Dodson & Son.	D	210.0	6	Kt Mb(?)	890	37.2	8-23-61	N	N	61	4	140	Federal observation well. Cased to 146 ft., slotted from 140 to 146 ft. See figs. 8, 13, 14, 22; tables 2, 3, 7.
*RTW-2	...do.....	H. W. Peerson Drilling Supply Co. and Hawley Dodson & Son.	D	420.0	8-6	Mb	745	29.7	12-28-60	N		62	7	205	Observation well. Cased 8-in. to 29.7 ft.; none below. Peerson drilled to 125 ft. in September 1954 (Peace, 1962, table 1, well B-109); Dodson deepened well to 420 ft. in November 1960. See figs. 8, 15, 23; tables 2, 3, 7.
RTW-3	...do.....	Hawley Dodson & Son.	D	190.0	6	Kt-Mb	960	...	.....	..	...	..	..	....	Well dry, abandoned and filled. See tables 2, 7.

*RTW-4	...do.....	...do.....	D	238.0	6	Kt-Mb	870	61.0	1-23-61	N	..	60	6	140	Observation well. Cased to 135 ft., slotted from 121 to 135 ft. See figs. 7, 8, 18-20; tables 2, 3, 7.
*RTW-5	...do.....	Adams-Massey Co.	D	113.0	6	Kt-Mb	860	55.9	9-14-51	N	..	61	11	60	Cased to 63.5 ft. Maximum yield September 1961 was 5 gpm. See tables 2, 3, 7.
*RTW-6	...do.....	...do.....	D	186.5	6	Kt	860	56.3	10-21-61	N	..	60	4	60	Cased to 136.7 ft., slotted from 46.6 to 69.9 ft. and from 85.4 to 90.4 ft. Water at 47 and 87 ft.; maximum yield on 9-18-61 less than 5 gpm. See fig. 16; tables 2, 3, 7.
*RTW-7	...do.....	...do.....	D	191.0	6	Mb Kt(?)	910	40.7	10-13-61	N	..	61	5	110	Cased to 93 ft., slotted from 75 to 89 ft. See figs. 17, 21; tables 2, 3, 7.
RTW-8	...do.....	...do.....	D	112.0	6	Kt-Mb	880	...	.....	..	....	..		....	Well dry, abandoned, and filled. See tables 2 and 7.
RTW-9	...do.....	...do.....	D	64.5	6	Kt	930	...	.....	..	....	..		....	Do.
RTW-10	...do.....	...do.....	D	116.0	6	Kt-Mb	930	...	.....	..	....	..		....	Cased to 61 ft. Well dry; plugged at 5 ft. and filled to surface. See tables 2, 7.
B-56	B. Mahan	H. W. Peerson Drilling Supply Co.	D	102	10	.....	800	...	.....	..	....	..		....	1952-54 city of Russellville test well. Cased to 20 ft. Well dry, abandoned, and filled. See table 5.
B-58	J. C. Steinecipher	...do.....	D	140.0	8	Mb	810	12.6	1-27-60	N	N	60	18	220	1952-54 city of Russellville test well. Aquifer reported weak. See fig. 10.
*B-105	City of Russellville.	...do.....	D	157	10	Mb	745	6.1	2- 4-53	T	N	..	7	175	1952 city of Russellville test well. Used as city water supply for short time. Cased 10-in. to 18 ft. Pump tested 400 gpm on 2-4-53, drawdown 9.9 ft. after 30 hrs. Dye test proved aquifer is contaminated by surface stream. 6-in. cavity at 41 ft. and small crevice at 100 ft. Driller's log, biological analysis, and pumping-test data in files of U.S. Geol. Survey. See tables 3 and 5.

Table 4.—*Records of test wells in the Russellville area*—Continued

Well	Owner	Driller	Type	Depth of well (feet)	Diameter of well (inches)	Water-bearing unit	Altitude of land surface (feet)	Water level		Method of lift	Use of water	Field determinations			Remarks
								Above (+) or below land surface (feet)	Date of measurement			Temperature (°F)	Chloride (Cl) (ppm)	Hardness as $CaCO_3$ (ppm)	
B-107	City of Russellville.	H. W. Peerson Drilling Supply Co.	D	112	10	.....	750	....	.....	..	.....	..	....		1952-54 city of Russellville test well. Cased 10-in. to 33 ft. Dry crevice at 80 ft. Well abandoned and filled. See table 5.
*B-108	Elbert Berryman	...do.....	D	62.9	10	Mb	750	13.1	7-22-59	N	N	..	..	....	1952-54 city of Russellville test well. See fig. 9.
B-112	Foss Weatherford	...do.....	D	200	10	.....	775	....	.....	..	.....	..	..	....	1952-54 city of Russellville test well. Cased 10-in. to 33 ft., none below. Well dry, abandoned, and filled. See table 5.
B-114	City of Russellville.	...do.....	D	155	...	.....	735	....	.....	..	.....	..	..	....	1952-54 city of Russellville test well. Reportedly drilled into good aquifer (75-100 gpm). Well abandoned and filled. See table 5.
B-118	U.S. Pipe and Foundry Co.	...do.....	D	110	8	.....	735	....	.....	..	.....	..	..	....	1952-54 city of Russellville test well. Cased to 19.6 ft. Estimated yield 5 gpm. Well abandoned and filled. See table 5.

Table 5.—*Drillers' logs of the city of Russellville's test wells*

	Thickness (feet)	Depth (feet)
Well B-56		
Owner: B. Mahan Driller: H. W. Peerson Drilling Supply Co. (McCarty and Green) Started: 7-29-52 Finished: 8-2-52		
Clay	15	15
Limestone	39	54
Shale	4	58
Limestone	9	67
Shale	7	74
Limestone	24	98
Shale	4	102
Cased 10-in. to 20 ft. Dry, abandoned and filled.		
Well B-105		
Owner: City of Russellville Driller: H. W. Peerson Drilling Supply Co. (McCarty and Green) Started: 6-30-52 Finished: 7-18-52		
Clay(?)	10	10
Limestone	30	40
Limestone (6-in. opening at 41 ft. hit water)	5	45
Limestone	53	98
Limestone. Crevice at 100 ft	4	102
Limestone	1	103
Shale	54	157
Limestone below		
Well B-107		
Owner: City of Russellville Driller: H. W. Peerson Drilling Supply Co. (McCarty and Green) Started: 6-17-52 Finished: 6-27-52		
Clay	8	8
Limestone	16	24
Limestone(?)	26	50
Limestone	17	67
Limestone, crevice 80 ft. no water	15	82
Limestone	25	107
Shale	5	112
Cased 10-in.(?) to 33 ft. Dry crevice at 80 ft., abandoned and filled.		

Table 5.—*Drillers' logs of the city of Russellville's test wells*—Continued

	Thickness (feet)	Depth (feet)
Well B-112		
Owner: Foss Weatherford Driller: H. W. Peerson Drilling Supply Co. (McCarty and Green) Started: 5-27-52 Finished: 6-16-52		
Boulder at 8 ft. went through 11 ft. hit boulder at 14 ft	15	15
Limestone	128	143
Limestone. Dry hole, putting in drill water	20	163
Limestone	2	165
Shale	30	195
Sandstone	5	200
Cased 10-in. to 33 ft. Dry, abandoned and filled.		
Well B-114		
Owner: City of Russellville Driller: H. W. Peerson Drilling Supply Co. (Eubank and Chance) Started: 2-1-52 Finished: 3-13-52		
Clay	5	5
Loose boulders	12	17
Solid lime	5	22
Boulders	1	23
Solid lime	2	25
Open with knots and mud	5	30
Boulders and crevices, rough	3	33
Open and boulders	5	38
Solid lime	5	43
Honeycomb and boulders	5	48
Some rock	1	49
Some rock, broke through	5	54
Solid lime, hard	11	65
Hard lime	3	68
Honeycomb, mud coming in	2	70
Soft lime	5	75
Hard lime	6	81
Solid lime, mud coming in from 68-70	21	102
Lime, soft place 109-114-119 ft	20	122
Lime rock	31	153
Sand rock. Pumped out all water in 15 min	2	155
Set pump to 53 ft. Pumped for 40 min. Hole caved in. Pumped slowly for 10 min. - picked up to 100 gpm. Stopped up - raised pump. Pumped 1 hour at 125 gpm from 43 ft. Abandoned and filled.		

Table 5.—*Drillers' logs of the city of Russellville's test wells*—Continued

	Thickness (feet)	Depth (feet)
Well B-118		
Owner: U.S. Pipe and Foundry Co. Driller: H. W. Peerson Drilling Supply Co. (Eubank and Bostick) Started: 1-18-52 Finished: 1-29-52		
Clay and sandy gravel, water at 8 ft., rock at 18 ft., set 8-in. pipe	18	18
Lime rock rough and broken, set 19 ft. 7-in. - 8-in. pipe	7	25
Lime rock, small crevice at 29 ft.; water level 6 ft	7	32
Lime rock	11	43
Lime rock (soft place 58 to 60 ft., some fine clay)	22	65
Hard lime	12	77
Shale	2	79
Lime rock	3	82
Hard lime	5	87
Soft lime	2	89
Hard lime	9	98
Soft rotten lime, rough	7	105
Sand rock, not too hard	5	110
Put in bridge, poured 8 bags cement, sealed pipe, drilled out cement, and bailed well dry; yield ± 5 gpm. Abandoned and filled.		

Table 6.—*Records of selected wells and springs in the Russellville area*

Well or spring: Numbers correspond to those on plate 2; asterisk indicates chemical analysis given in table 3.

Type: D, drilled well; Du, dug well; S, spring.

Depth of well and water level: Depths shown in feet are reported; those shown in feet and tenths are measured.

Altitude of land surface: Interpolated from topographic quadrangle maps.

Method of lift: F, gravity flow; M, manual; N, none; T, turbine (deep well); Tj, jet; Ts, submersible.

Use: D, domestic; N, none; P, public supply; R, recreation; S, stock.

Water-bearing unit: Mh, Hartselle Sandstone; Mb, Bangor Limestone; IPpv, Pottsville Formation; Kt, Tuscaloosa Group (undifferentiated); R, regolith.

Well or spring	Owner	Driller	Type	Depth of well (feet)	Diameter of well (inches)	Water-bearing unit	Altitude of land surface (feet)	Water level		Method of lift	Use of water	Field determinations			Remarks
								Above (+) or below land surface (feet)	Date of measurement			Temperature (°F)	Chloride (Cl) (ppm)	Hardness as $CaCO_3$ (ppm)	
*B-9	C. Hill	Warren Kent Drilling Co.	D	61.7	6	Mb	670	7.1	8- 4-59	N	N	62	117	1,070	Cased to 25 ft. Sulfurous and lime taste reported. See fig. 11.
*B-17	W. A. Pruitt	...do	D	52.9	6	Mb	710	49.5	8-10-59	Tj	D	..	18	322	Cased to 15 ft. Supplies 2 families.
*B-34	R. A. Bitnell	...do	D	204.4	6	Mh	710	128.1	8- 6-59	Tj	D	..	32	76	Soda taste reported.
*B-45	E. Bean	John Harris Drilling Co.	D	153.0	6	Mh	660	80.7	7-29-59	N	N	62	18	25	Soda taste reported. See fig. 11.
B-55	City of Russellville.		S		..	Kt	820			F	R	62	4	90	Burgess Lake Spring. Supplies city pool. See fig. 6.
*B-60	B. S. Henry	P. E. Chipolett Drilling Co.	D	120	6	Mb	740	13.0	7-23-59	Ts	D	..	11	264	

*B-125	State of Alabama	.....	S	.....	..	Kt	740	.....	.....	F	P	62	11	75	Waco Spring. Supplies more than 200 families in late summer and fall. See fig. 6.
*C-1	Joe McNatt.....	.....	Du	74.3	36	Kt	930	69.3	8-13-59	M	D	64	11	100	Cased to 74 ft. Supply inadequate in fall.
*C-12	O. E. Bolton.....	Warren Kent Drilling Co.	D	72.0	6	Mb	735	21.3	8-20-59	Tj	D	62	33	245	See fig. 12.
C-23	T. H. Broyles	T. H. Broyles....	D	67.9	6	Kt	985	40.5	8-17-59	N	N	60	4	45	See fig. 11.
*C-37	U.S. Pipe and Foundry Co.	U.S. Pipe and Foundry Co.	D	65.5	8	Kt	860	2.9	1- 4-60	N	N	..	...	.....	See fig. 10.
*I-5	J. B. Hester, Jr...	P. E. Chipolett Drilling Co.	D	80	6	Mb	820	65.3	10-15-59	Tj	D	..	25	200	
*I-8	J. Thorne	.....	Du	80.5	36	Kt	860	43.2	10-21-59	Tj	S	60	25	130	See fig. 12.
J-4	Georgia Marble Co.	.....	S	.....	..	Mb	700	.....	.....	F	D	61	4	160	Supplies 3 families. See fig. 5.
*J-11	Dewey Grissom...	Warren Kent Drilling Co.	D	67.5	6	Mb	680	40.0	9-29-59	N	N	63	11	177	Cased to 36 ft. Pump tested 32 gpm on 11-5-59, drawdown 9.4 ft. after 4 hrs. 10 min. Electric log in files of U.S. Geol. Survey.
J-30	J. O. Hendricks...	B. Copeland Drilling Co.	D	118.1	6	Mb	695	32.1	10- 7-59	Tj	D	62	11	160	Sulfurous taste and odor reported. See fig. 12.
J-41	Lee Underwood ...	.....	S	.....	..	R	700	.....	.....	Tj	D	61	11	145	Underwood Spring. See fig. 5.
J-60	J. W. Bray.....	Warren Kent Drilling Co.	D	113.9	6	Kt IPpv(?)	960	29.8	10-19-59	Tj	N	62	4	110	Before August 1960 was used to supply 150 hogs. See fig. 12.
K-21	Mary Harris.....	-- Hodd	D	98.4	6	Mb	710	17.7	9-23-59	N	N	60	4	45	Cased to 12 ft. Sulfurous taste reported. See fig. 11.
K-48	T. Clark	.....	D	57.6	6	IPpv	1,070	44.2	10-29-59	M	D	63	4	40	See fig. 11.
N-17	L. Smith.....	.....	D	14.7	6	Kt	1,010	15.9	10-27-59	Tj	D	60	18	30	See fig. 11.

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*

	Thickness (feet)	Depth (feet)
RTW-1		
Location: SW¼NW¼NW¼ sec. 19, T. 6 S., R. 11 W. Altitude: 890 feet		
Tuscaloosa Group (undifferentiated)		
No record	25	25
Sand, white to very pale orange, medium-grained, rounded to subangular, resinous luster, in part translucent	15	40
Silt, tannish-white; white to very pale orange medium- to fine-grained rounded sand; light-tan clay; light-tan rounded chert	5	45
Gravel, light-gray to white, cherty, rounded, weathers reddish tan to tan, maximum diameter of 25 mm; white to very pale orange fine- to medium-grained rounded sand, resinous luster, translucent (gravel percentage decreased from 50 to 60 feet)	22	67
Gravel, reddish-tan to white, cherty, rounded, maximum diameter of 15 mm; minute amount of sand (cavings?)	5.5	72.5
Gravel, reddish-tan to yellowish-white, cherty, rounded, maximum diameter of 15 mm; white to very pale orange medium- to fine-grained rounded translucent sand	2.5	75
Sand, yellowish-white to white, medium- to fine-grained, rounded to subangular, translucent, in part transparent	2.5	77.5
Gravel, reddish-tan to yellowish-white, cherty, rounded, maximum diameter of 25 mm; white to very pale orange fine- to very fine grained rounded to subangular translucent in part transparent sand. Percentage of gravel increases from 80 to 83 feet and decreases from 83 to 86 feet; minute fragments of shaly limestone from 86 to 90 feet	12.5	90
Iron ore, brown, fine (limonite)	9	99
Iron ore, brown, fine to massive (limonite); brown rounded gravel, maximum diameter of 20 mm; minute fragments of limestone	5	104
Iron ore, brown, massive (limonite); varicolored cherty gravel (possible cavings)	12	116
Sand, white to pale yellowish-orange, medium-grained, rounded to subangular, resinous luster, translucent, in part transparent; fine brown iron ore (limonite); fragments of chert gravel (possible cavings)	4	120
Clay, yellowish-brown; fine to massive brown iron ore (limonite); varicolored rounded gravel, maximum diameter of 15 mm; iron ore and gravel (possible cavings). Water between 141 and 141.7 feet	21.7	141.7
Gravel, brownish-yellow, cherty, rounded; yellowish-white to white fine to very fine grained rounded to subangular sand; fine brown iron ore (limonite); small percentage of gray limestone; crinoid stem plates	4.3	146

Table 7.–*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*–Continued

	Thickness (feet)	Depth (feet)
RTW-1–Continued		
Bangor Limestone		
Limestone, medium-gray, hard, dense, coarse texture; reddish-brown to yellowish-white cherty rounded gravel; yellowish-white sand; fine brown iron ore (limonite); crinoid stem plates; gravel, sand, and iron ore (possible cavings); possible sand layer from 147 to 148 feet	3	149
Cavity	2	151
Limestone, medium-gray, hard, dense, coarse texture, slight weathering on scattered cuttings at 151 feet and 170-172 feet; gravel, iron ore, and sand (cavings?); numerous crinoid stem plates. Gravel increases from 153 to 156 feet but decreases below 156 feet; soft spot from 170 to 172 feet	49	200
Limestone, medium-gray, hard, dense; gray soft thinly fissile shale; crinoid stem plates and *Lepidodendron(?)* fragments. Cavings of sand, broken gravel, and iron ore	10	210
RTW-2*		
Location: SW¼NW¼SE¼ sec. 29, T. 6 S., R. 11 W. Altitude: 745 feet		
Regolith		
No record	14	14
Clay	12	26
Bangor Limestone		
Rock	2	28
Water at 36 and 42 feet	15	43
Lime rock, hard; water at 21 ft. 4 in., very muddy	14	57
Lime rock. Soft place at 72, 88, 94, and 96 ft	58	115
Shale	10	125
Shale, medium-gray, soft	10	135
Limestone, medium-gray to olive-gray, medium-hard, coarse texture, in part crystalline, carbonaceous material on scattered cuttings; medium-gray shale	5	140
Shale, medium-gray, soft; minute amount of gray crinoidal limestone	15	155
Limestone, light-gray, medium-hard, sugary texture; minute amount of medium-gray shale	5	160
Limestone, light-gray, medium-hard, crinoidal; minute amount of gray shale (cavings?)	5	165
Limestone, medium dark-gray, medium-hard to hard, coarse to sugary texture; minute amount of dark-gray crinoidal and slightly pyritic limestone; small amount of gray crinoidal limestone (cavings?)	40	205

*Descriptions and geologic contacts from 0 to 125 feet based on driller's log.

Table 7.--*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*--Continued

	Thickness (feet)	Depth (feet)
RTW-2--Continued		
Bangor Limestone--Continued		
Shale, medium light-gray, soft, silty, calcareous; small amount of gray limestone (cavings?)	5	210
Limestone, medium light-gray, argillaceous, silty; gray shale (cavings?)	5	215
Shale, medium- to dark-gray, medium hard to hard, calcareous, conchoidal fracture; medium light-gray silty argillaceous pyritic limestone. Predominantly shale from 260 to 280 feet	65	280
Hartselle Sandstone		
Sandstone, light-gray, very fine to fine-grained, subrounded, cemented partially by calcite, pyritic, brown carbonaceous(?) stain on numerous cuttings; minute amount of medium-gray shale (cavings?)	35	315
Sandstone, light-gray, very fine to fine-grained, subrounded to rounded, cemented by calcite, pyritic; minute amount of medium dark-gray soft shale. Concentration of carbonaceous(?) material from 315 to 320 feet	60	375
Sandstone, light- to medium-gray, quartzose, very fine grained	5	380
Sandstone, medium light-gray to light olive-gray, quartzose, very fine grained to silty, slightly pyritic; minute impregnations of black hard material; cementing material includes some calcite	20	400
Golconda Formation		
Siltstone, medium-gray, cemented by calcite; medium-gray shale; medium light-gray to light olive-gray quartzose very fine grained to silty sandstone	10	410
Siltstone, medium-gray, cemented by calcite; medium-gray pyritic shale	10	420
RTW-3		
Location: SE¼SE¼SW¼ sec. 24, T. 6 S., R. 12 W. Altitude: 960 feet		
Tuscaloosa Group (undifferentiated)		
Gravel, grayish-orange to dark yellowish-orange, cherty, rounded, weathered; dark yellowish-orange medium-grained subangular to rounded weathered sand	30	30
Iron ore, brown, fine (limonite); sand, gravel, and limestone fragments	22.5	52.5

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-3—Continued		
Bangor Limestone		
Limestone, light-gray, hard, coarse texture, oolitic; gravel, sand, and iron ore cavings. No cavings below 60 ft	52.5	105
Limestone, light-gray, moderately hard, sugary texture	5	110
Limestone, light-gray, hard, coarse texture, oolitic	55	165
Limestone, medium light-gray to medium dark-gray, hard, coarse texture; minute amount of light-gray sugary texture limestone	10	175
Limestone, medium light-gray to medium dark-gray, hard, coarse texture	15	190
RTW-4		
Location: NE¼SE¼ sec. 26, T. 6 S., R. 12 W. Altitude: 870 feet		
Tuscaloosa Group (undifferentiated)		
Sand, light-tan to brown, fine-grained, hard, quartzose, rounded, weathered; very light gray hard weathered rounded cherty gravel	20	20
Gravel, light-tan to reddish-brown, cherty, hard, rounded, weathered; light-tan to brown fine-grained hard rounded sand	50	70
Clay, reddish-brown; light-tan to reddish-brown hard rounded cherty gravel; reddish-brown very fine grained rounded quartzose sand	10	80
Gravel, very light gray to reddish-brown, cherty, hard, rounded, weathered; light-tan to brown fine-grained hard rounded sand	15	95
Iron ore, brown (limonite)	5	100
Clay, gray; brown chert; brown iron ore. Chert and iron ore possibly cavings	10	110
Gravel, light-gray to brown, cherty, hard, rounded, weathered; brown fine-grained sand	20	130
Bangor Limestone		
Limestone, gray, crinoidal, very minute amount increases to about 50 percent at 200 feet; abundant light-gray to brown cherty hard rounded weathered gravel (cavings?); brown fine-grained sand (cavings?)	90	220

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-4—Continued		
Bangor Limestone—Continued		
Limestone, light olive-gray, hard, crinoidal, cryptocrystalline; light-brown to light brownish-gray soft shale; pale yellowish-orange to yellowish-gray hard rounded weathered cherty gravel (cavings?). Predominantly limestone from 225-230 feet; possibly shale cavings below 225 feet	10	230
Limestone, light olive-gray to speckled light and medium dark-gray, hard, crinoidal, cryptocrystalline, minutely pyritic; very small amount of gravel and shale cavings	8	238
Driller reported broken limestone from 130 to 220 feet; therefore, all gravel and sand cuttings from 130 to 238 feet may be cavings.		
RTW-5		
Location: SW¼SE¼ sec. 26, T. 6 S., R. 12 W. Altitude: 860 feet		
Tuscaloosa Group (undifferentiated)		
Gravel, moderate reddish-brown to light-brown, cherty, hard, rounded, black stain on scattered cuttings; pale yellowish-orange to light-brown medium to very coarse grained rounded to subangular weathered quartzose sand; minute amount of limestone and quartzose gravel	36	36
Iron ore, brown, fine (limonite); gravel and sand cavings	3	39
Gravel, very pale orange to pale yellowish-brown, cherty, rounded, weathered; small amount of brown clay and yellowish-orange sand; iron ore cavings	19	58
Bangor Limestone		
Limestone, light brownish-gray to light-gray, hard, crinoidal	2	60
Crevice filled with mud, gravel and water	2.5	62.5
Limestone, light-gray, hard, crystalline, and oolitic	7.5	70
Limestone, light-gray, hard, oolitic; gravel, iron ore, and sand cavings possibly coming from crevice above 62.5 feet or from very small dry clay, sand, and iron-ore-filled crevices between 70- and 93-foot depth; fewer cavings below 93 feet	38	108
Limestone, medium dark-gray, dense, hard	5	113

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-6		
Location: SW¼SW¼NW¼ sec. 25, T. 6 S., R. 12 W. Altitude: 860 feet		
Tuscaloosa Group (undifferentiated)		
Clay, moderate-brown, mixed with many minute pieces of quartzose sand and highly weathered cherty gravel	5	5
Sand, very pale orange to light-brown, quartzose and cherty, fine- to coarse-grained; grayish-orange to yellowish-gray cherty rounded gravel, maximum diameter of 20 mm; small amount of brown clay	15	20
Sand, clear to very pale orange, quartzose, fine- to medium-grained, subrounded to angular; very pale orange to light-gray cherty rounded weathered gravel, maximum diameter of 50 mm	15	35
Gravel, very pale orange to yellowish-gray to very light gray, cherty, rounded, maximum diameter of 50 mm; minute amount of fine light-gray sand	40	75
Sand, very light gray to pinkish-gray, quartzose, silty to fine-grained, subrounded; light-brown clay mottled dark yellowish orange	3	78
Clay, light-brown, mottled dark yellowish orange, sandy(?), micaceous; cavings of gravel and sand	11	89
Gravel, white to light-gray, cherty, rounded, maximum diameter of 30 mm	2	91
Clay, dark yellowish-orange, sandy; small amount of gravel cavings	10.5	101.5
Iron ore, brown, fine (limonite)	2.5	104
Clay, dark yellowish-orange, sandy; minute amount of gravel and iron ore cavings	7.5	111.5
Bangor Limestone		
Limestone, medium light-gray, moderately hard, oolitic, crinoidal. Weathering shows on numerous cuttings. Broken limestone and clay from 115 to 119 feet	8.5	120
Clay, pale yellowish-orange, sandy	12.5	132.5
Limestone, light-gray, moderately hard, oolitic, weathered white	1.5	134
Limestone, medium light-gray, hard, dense, coarse texture from 171 to 180 feet; pyrite; calcite vein; *Lepidodendron* fragment. Black argillaceous or carbonaceous flakes from 142 feet downward causes color variation from medium light gray to dark gray	46	180
Limestone, light-gray, moderately hard, very oolitic	6	186

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-7		
Location: NW¼NE¼NE¼ sec. 24, T. 6 S., R. 12 W. Altitude: 910 feet		
Tuscaloosa Group (undifferentiated)		
Sand, clear to light-brown, medium to very coarse grained, subangular to subrounded, quartzose; light-brown to moderate reddish-brown sandy clay; white to pale yellowish-orange weathered cherty gravel	21	21
Gravel, very pale orange to bluish-white, cherty, rounded, weathered, maximum diameter of 25 mm; clear to dark yellowish-orange medium- to coarse-grained subangular to subrounded quartzose sand. Carbonaceous (asphaltic?) material on several cuttings from 21 to 30 feet. Crinoid stems	17	38
Iron ore, brown (limonite); minute amount of gravel and sand (cavings?)	5	43
Clay, dark yellowish-orange; gravel and iron ore (cavings?)	15	58
Gravel, white to grayish-orange, cherty, rounded, weathered, maximum diameter of 15 mm; minute amount of light-brown clay	12	70
Bangor Limestone		
Limestone, pinkish-gray to light-gray, slightly weathered, coarse texture, crinoid stem imprints in scattered cuttings	3	73
Limestone, medium-gray to dark-gray, hard, crystalline, coarse texture, crinoid stems	7.5	80.5
Cavity filled with gravel (maximum diameter of 40 mm) and water	.5	81
Limestone, medium-gray, hard, crystalline; carbonaceous (asphaltic?) material on a few cuttings from 96 to 101 feet	20	101
Limestone, light-gray, medium hard, cryptocrystalline to slightly crystalline, sandy texture	6.5	107.5
Cavity filled with water, gravel (maximum diameter of 40 mm), and light-gray sandy clay	2	109.5
Limestone, white to pinkish-gray, soft, weathered, carbonaceous (asphaltic?) flecks on numerous cuttings; crinoid stems and *Lepidodendron* fragments	1	110.5
Cavity	.3	110.8
Limestone, white to pinkish-gray, soft	.2	111
Cavity	.3	111.3
Limestone, medium light- to medium dark-gray, hard, crystalline, oolitic, and crinoidal, very oolitic at 126 feet; *Lepidodendron* fragments	20.7	132

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

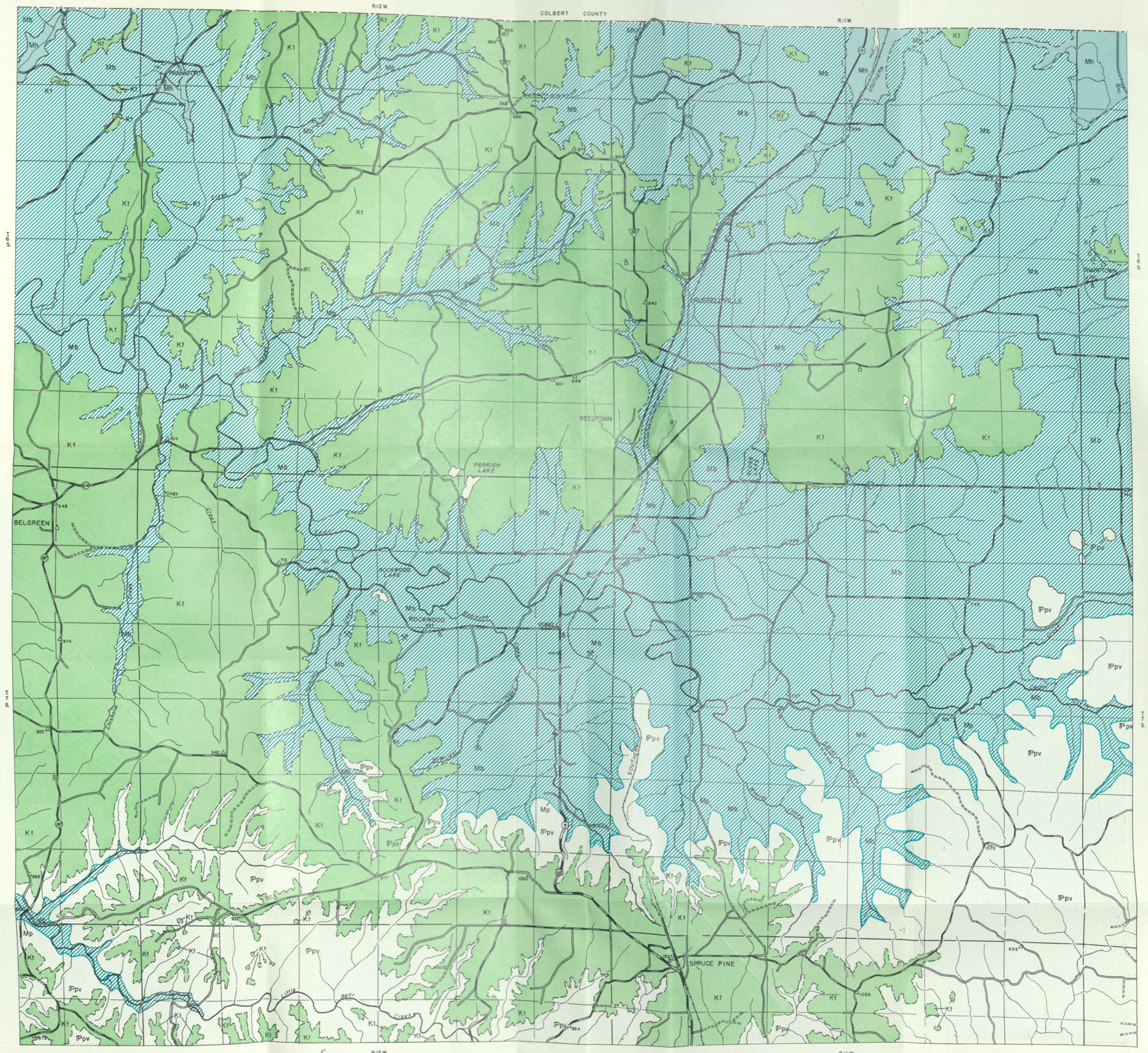
	Thickness (feet)	Depth (feet)
RTW-7—Continued		
Bangor Limestone—Continued		
Cavity filled with gravel, mud, and water	1	133
Limestone, very light to light-gray, medium hard, oolitic to crystalline	20.5	153.5
Limestone, light to medium light-gray, medium hard, crinoid plates. Gas odor in sample from 159 to 165 feet	37.5	191
RTW-8		
Location: NW¼NE¼SE¼ sec. 24, T. 6 S., R. 12 W. Altitude: 880 feet		
Tuscaloosa Group (undifferentiated)		
Gravel, very pale orange, cherty, rounded, weathered; quartzose subrounded to rounded fine sand; pale reddish-brown clay	25	25
Clay, light-brown; very pale orange gravel (cavings?)	2	27
Iron ore, brown (limonite); light-brown clay; yellowish-brown rounded gravel (cavings?)	13	40
Gravel, very pale orange to light-brown, cherty, rounded, weathered; light-brown clay and iron ore cavings	15	55
Clay, grayish-orange to grayish-yellow, sandy; *Lepidodendron* fragments and imprints; gravel and iron ore cavings	15	70
Clay, grayish-yellow; very pale orange rounded weathered gravel; small amount of light-gray coarse texture limestone (boulder?)	5	75
Gravel, white to very pale orange to grayish-orange-pink, cherty, rounded, weathered; grayish-orange clay	5	80
Bangor Limestone		
Limestone, light-gray, medium hard, crinoidal, micaceous	20	100
Limestone, medium-gray, very soft	12	112

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-9		
Location: NW¼SE¼SW¼ sec. 18, T. 6 S., R. 11 W. Altitude: 930 feet		
Tuscaloosa Group (undifferentiated)		
Gravel, moderate orange-pink to pale yellowish-orange, cherty, rounded, maximum diameter of 50 mm; clear to moderate orange-pink quartzose medium-grained subrounded to rounded sand; minute amount of clay	15	15
Clay, dark yellowish-orange to pinkish-gray; yellowish-gray rounded gravel; minute amount of quartzose sand	22	37
Gravel, very light gray stained light brown, cherty, rounded, maximum diameter of 65 mm; minute amount of sand and clay	8	45
Limestone (ledge or boulder), light-gray, hard, coarse texture; some gravel and sand (cavings?)	6	51
No sample	3	54
Sand, clear to waxey luster, quartzose, subangular to rounded; pale yellowish-orange rounded gravel; crinoid plates and *Lepidodendron* fragments	3.5	57.5
Gravel, pale yellowish-orange, cherty, rounded; quartzose subangular to rounded sand; gray hard limestone (boulders?)	7	64.5
RTW-10		
Location: NE¼SE¼NE¼ sec. 13, T. 6 S., R. 12 W. Altitude: 930 feet		
Tuscaloosa Group (undifferentiated)		
No sample	5	5
Gravel, very pale orange, cherty, rounded, weathered, maximum diameter of 20 mm; quartzose subrounded to rounded very fine sand; small amount of pale reddish-brown clay	21	26
No sample. Driller reported boulder. Lost cuttings in well	4	30
Iron ore, brown, heavy (limonite); pale yellowish-orange rounded cherty gravel; quartzose subrounded fine to very fine grained sand. Cuttings include about 10 percent iron ore	5	35
Iron ore, brown, heavy (limonite); minute gravel and sand cavings	7	42
No sample. Lost drill water and cuttings	4	46

Table 7.—*Sample descriptions of U.S. Geological Survey test wells in the Russellville area*—Continued

	Thickness (feet)	Depth (feet)
RTW-10—Continued		
Tuscaloosa Group (undifferentiated)—Continued		
Gravel, pale yellowish-orange to light-brown, cherty, rounded, weathered, maximum diameter of 50 mm; small amount of iron ore, clay, and sand (cavings?); crinoid plate fragments. Sample very mixed from 53 to 60 feet	14	60
Bangor Limestone		
Limestone, light-gray, soft, sugary texture, slight amount of weathering shows on scattered cuttings to 65 feet, crinoid plates and *Lepidodendron* fragments; very light gray oolitic weathered limestone; minute amount of iron ore and gravel cavings	5	65
Limestone, light-gray, soft to moderately hard, coarse texture, oolitic, waxey luster from some cuttings; crinoid stem fragments	8.5	73.5
Limestone, medium light-gray mottled with dark-gray, moderately hard, coarse texture; light-gray soft to moderately hard sugary texture limestone	5	78.5
Limestone, medium light-gray, hard, cryptocrystalline, dense	11.5	90
Limestone, medium light-gray mottled with dark-gray, moderately hard to hard, coarse texture	20	110
Limestone, light-gray, moderately hard, oolitic	6	116



EXPLANATION

Kt — Tuscaloosa Group (undifferentiated)
Sand, clay, and gravel, yellow, orange, red, and red-purple, irregularly bedded; the gravel is cherty and the sand is quartzose. Brown iron ore occurs in some areas. Yields supplies up to 350 gpm in some places; generally yields supplies adequate for farm and domestic use

CRETACEOUS

IPpv — Pottsville Formation
Shale, alternating black to light-brownish- or yellowish-gray beds, fissile to thin-bedded; gray fine- to coarse-grained quartzose massive sandstone, generally weathered greenish- to reddish-gray to black. Yields small supplies for domestic use; water occurs in openings along bedding and joint planes, and in the beds of porous sandstone. Water is low in chloride content and soft to moderately hard

PENNSYLVANIAN

Mp — Pennington Formation
Shale, red and green, interbedded with thin layers of gray crinoidal limestone. Shown as line where extremely thin. Not an aquifer

Mb — Bangor Limestone
Limestone, yellowish, to very light to dark-gray, medium-crystalline to dense, crinoidal, oolitic, in part silty or cherty; basal 25 to 120 feet is yellowish gray calcareous shale interbedded with lenticular thick- to thin-bedded crinoidal limestone. Yields supplies up to 200 gpm in a few places; most supplies are of limited quantity and water levels are low during dry seasons. Water occurs in openings along fractures, joints, and bedding planes, and in solution cavities. The water is generally very hard

Mh — Hartselle Sandstone
Sandstone, light- to yellowish-gray, very fine to medium-grained, friable, thick-bedded to massive, locally calcareous or silty, or thin-bedded and includes layers of black shale. Yields less than 2 gpm of moderately hard to hard water. Water from one source was high in sulfate and fluoride content

MISSISSIPPIAN

CARBONIFEROUS

Contact
Dashed where approximately located

Mine or quarry

1 ½ 0 1 Mile

Base modified from TVA-USGS topographic quadrangle sheets

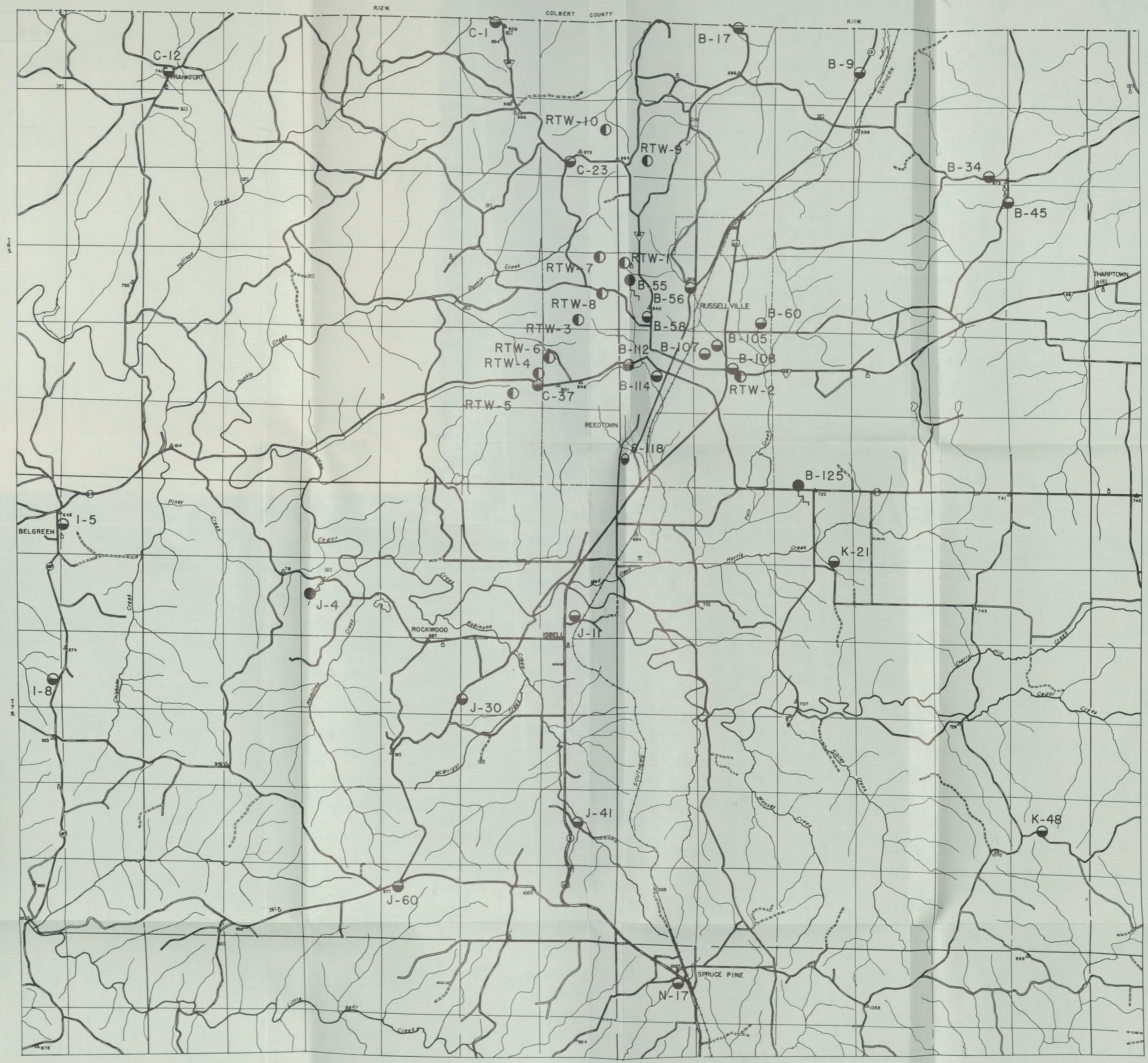
Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with
WATER and SEWAGE BOARD
of the
CITY OF RUSSELLVILLE
and the
GEOLOGICAL SURVEY OF ALABAMA

4° TRUE NORTH / MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1945

GEOLOGIC MAP OF THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.
1963



Base modified from TVA-USGS topographic quadrangle sheets

Prepared by
United States Geological Survey
in cooperation with
Water and Sewage Board
of the City of Russellville, and
Geological Survey of Alabama

TRUE NORTH
MAG. NORTH

APPROXIMATE MEAN
DECLINATION, 1945

LOCATION OF SELECTED WELLS AND SPRINGS IN THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.

1964

1 ½ 0 1 Mile

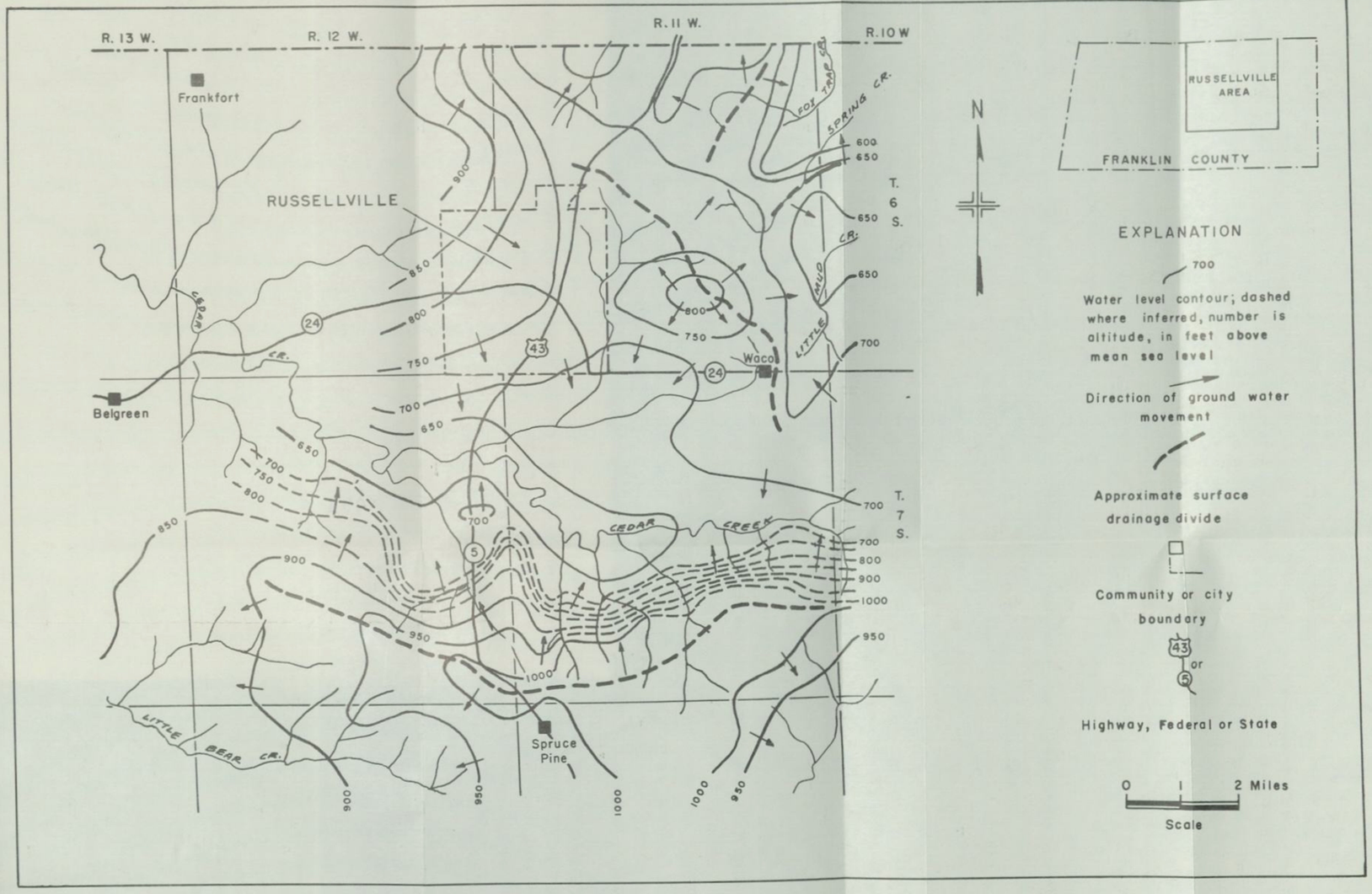
EXPLANATION

C-37
Well

RTW-3
USGS test well

J-4
Spring

Four-lane highway
Paved highway
Improved road
43 U.S. highway
5 State highway
48 County highway
Bench mark
(number denotes elevation)



GROUND-WATER MOVEMENT IN THE RUSSELLVILLE AREA, 1961

Base modified from TVA-USGS topographic quadrangle sheets

Prepared by
United States Geological Survey
in cooperation with
Water and Sewage Board
of the City of Russellville, and
Geological Survey of Alabama

TRUE NORTH
MAG. NORTH
APPROXIMATE MEAN
DECLINATION, 1945

LOCATION OF SELECTED WELLS AND SPRINGS IN THE RUSSELLVILLE AREA, ALABAMA

By Richard R. Peace, Jr.

1964

1 ½ 0 1 Mile

EXPLANATION

C-37 Well

RTW-3 USGS test well

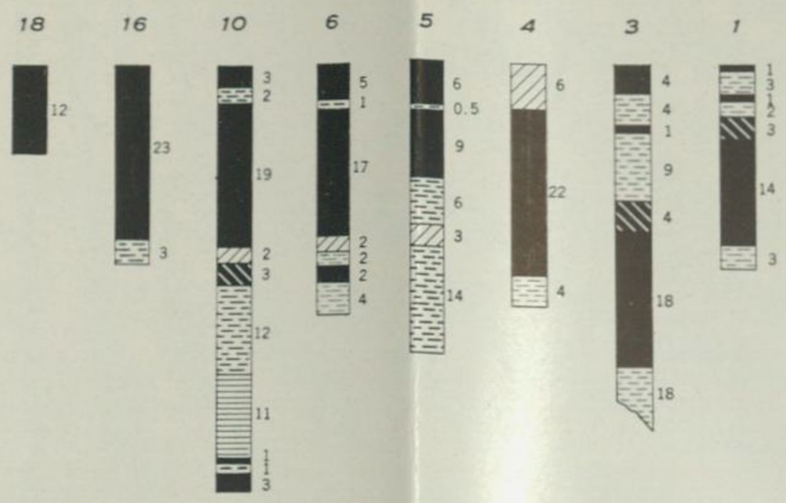
J-4 Spring

Four-lane highway
Paved highway
Improved road
43 U.S. highway
5 State highway
46 County highway
Bench mark (number denotes elevation)

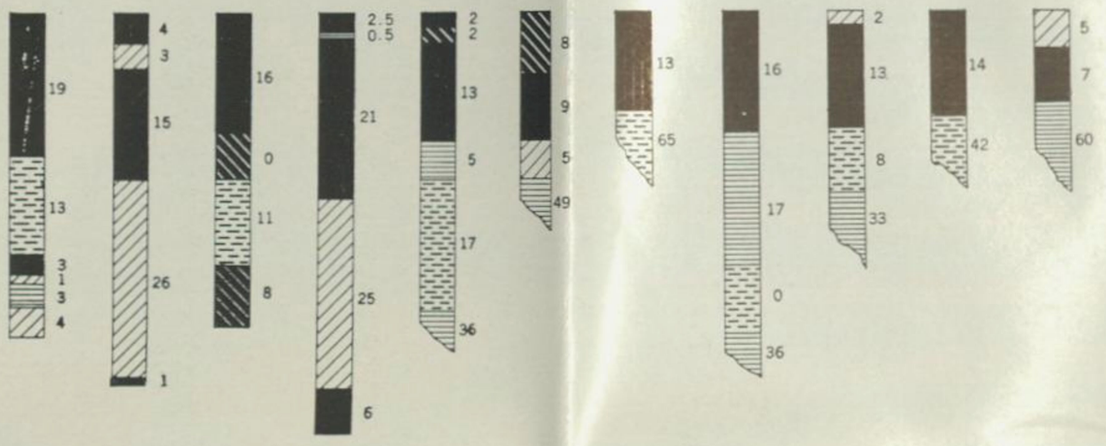
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

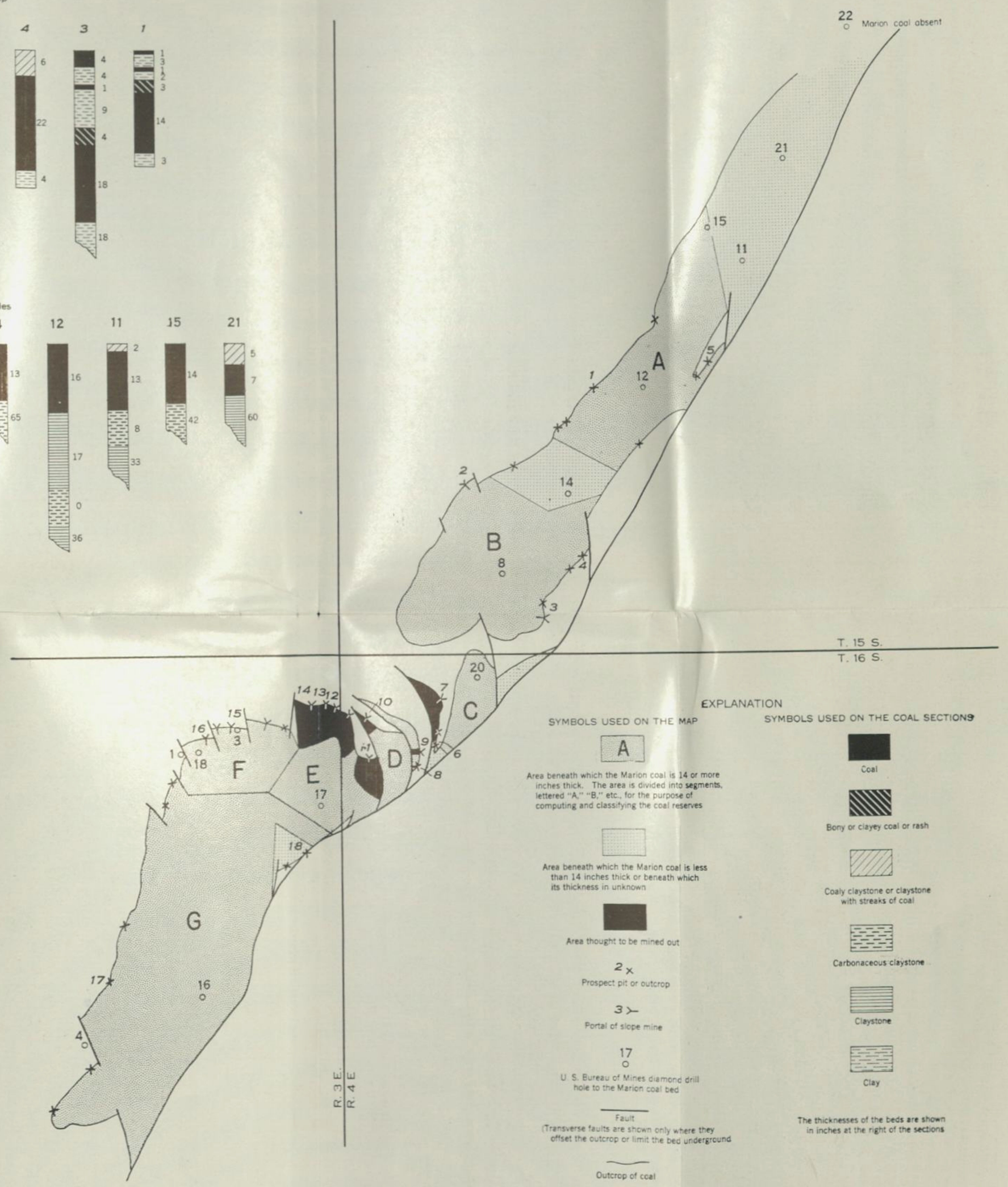
PLATE 7

Coal sections along the outcrop



Coal sections in diamond drill holes





EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Marion coal is 14 or more inches thick. The area is divided into segments, lettered "A," "B," etc., for the purpose of computing and classifying the coal reserves

Area beneath which the Marion coal is less than 14 inches thick or beneath which its thickness in unknown

Area thought to be mined out

2 ×
Prospect pit or outcrop

3 >—
Portal of slope mine

17
○
U. S. Bureau of Mines diamond drill hole to the Marion coal bed

Fault
(Transverse faults are shown only where they offset the outcrop or limit the bed underground

Outcrop of coal

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

Carbonaceous claystone

Claystone

Clay

The thicknesses of the beds are shown in inches at the right of the sections

MAP AND SECTIONS OF THE MARION COAL BED

BY
HOWARD E. ROTHROCK

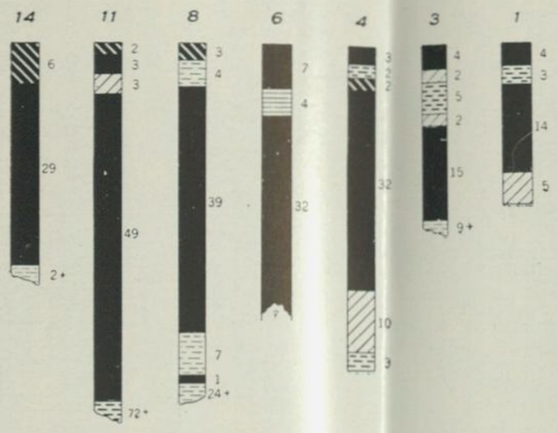
1 ½ 0 1 Mile

1948

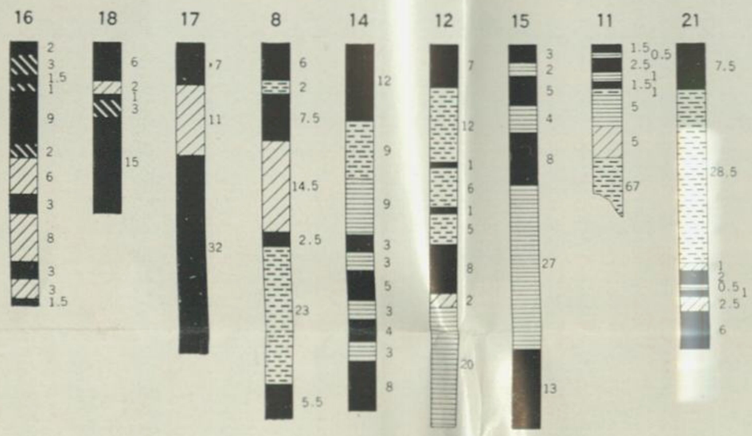
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 8

Coal sections along the outcrop



Coal sections in diamond drill holes



EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Broken Arrow coal is 14 or more inches thick. The area is divided into segments, lettered "A," "B," etc., for the purpose of computing and classifying the coal reserves

Area beneath which the Broken Arrow coal is less than 14 inches thick or beneath which its thickness is unknown

Area thought to be mined out

2x

Prospect pit or outcrop

5>

Portal of slope mine

17

U. S. Bureau of Mines diamond drill hole to the Broken Arrow coal bed

Fault
(Transverse faults are shown only where they offset the outcrop or limit the bed underground)

Outcrop of coal

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

Carbonaceous claystone

Claystone

Clay

The thicknesses of the beds are shown in inches at the right of the sections

MAP AND SECTIONS OF THE BROKEN ARROW COAL BED

BY
HOWARD E. ROTHROCK

1 ½ 0 1 Mile

1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 5

Coal sections along the outcrop.

EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Fairview coal is 14 or more inches thick. The area is divided into segments lettered "A," "B," and "C," for the purpose of computing and classifying the coal reserves

Area beneath which the Fairview coal is less than 14 inches thick or beneath which its thickness is unknown

Area thought to be mined out

2 × Prospect pit or outcrop

3 Portal of slope mine

17 ○ U. S. Bureau of Mines diamond drill hole to the Fairview coal bed

Fault
(Transverse faults are shown only where they offset the outcrop or limit the bed underground)

Outcrop of coal

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

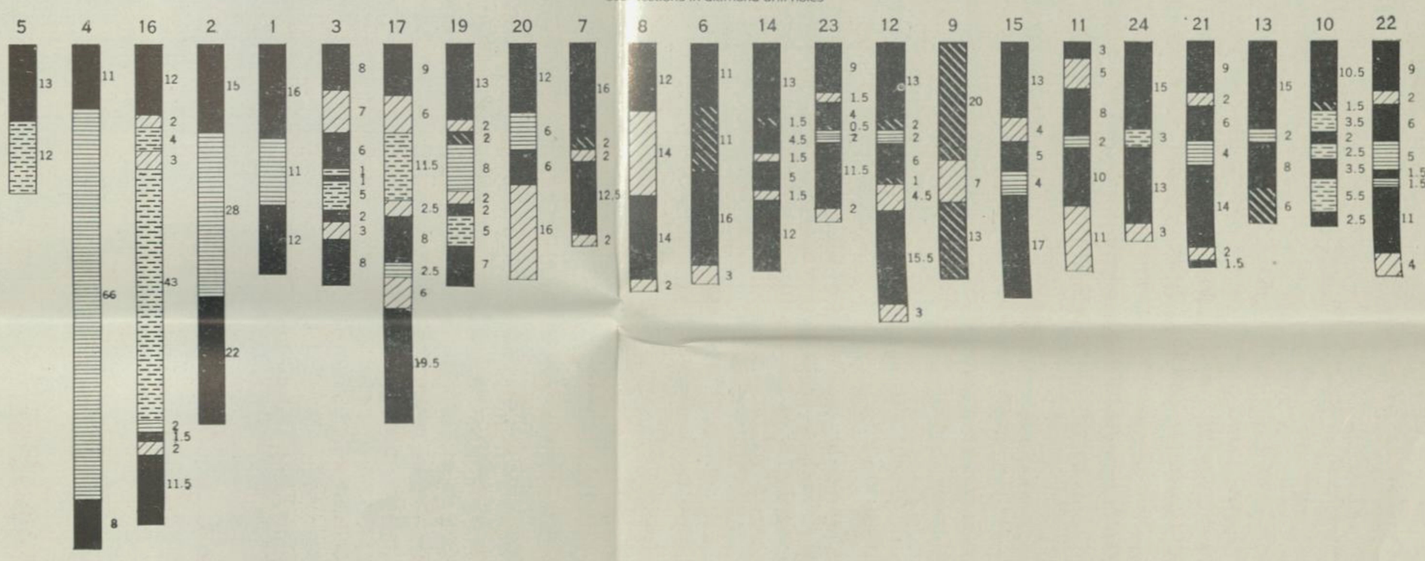
Carbonaceous claystone

Claystone

Clay

The thicknesses of the beds are shown in inches at the right of the sections

Coal sections in diamond drill holes



MAP AND SECTIONS OF THE FAIRVIEW COAL BED

BY
HOWARD E. ROTHROCK

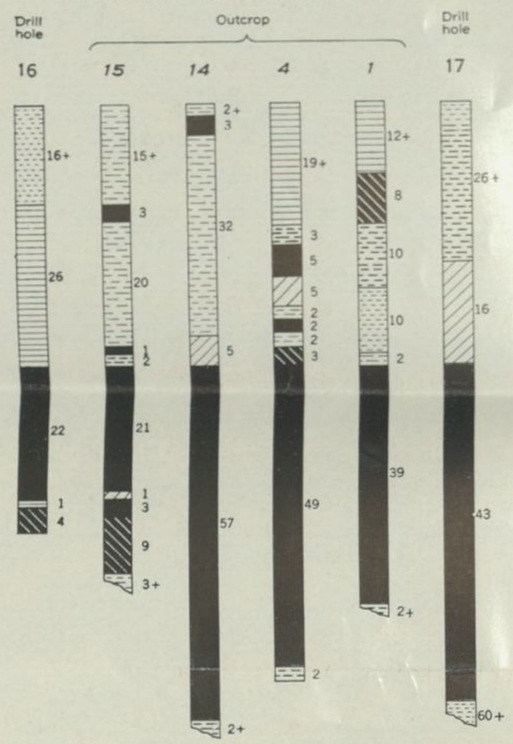
1 ¼ 0 1 Mile

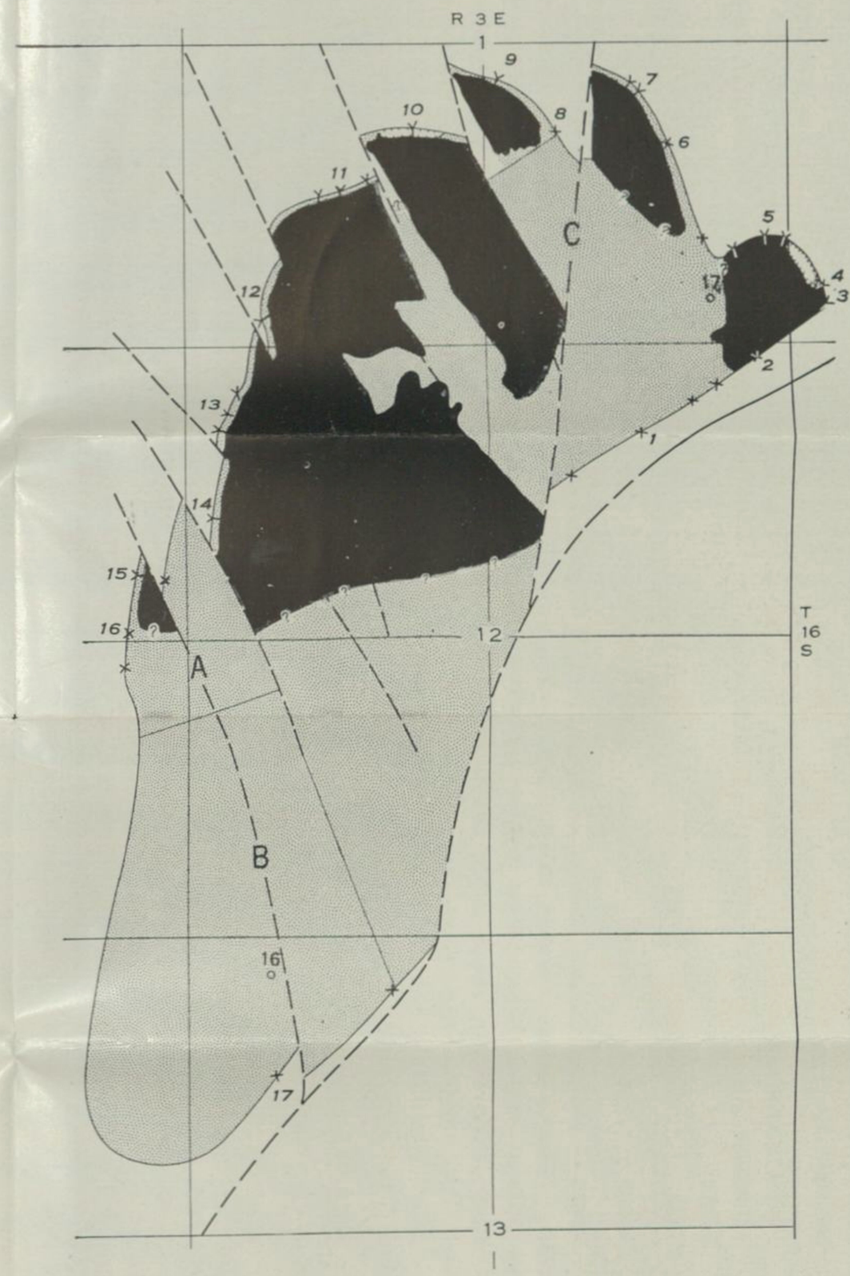
1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 9

Coal sections in drill holes and along the outcrop





EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Coal City coal is 14 or more inches thick. The area is divided into segments, lettered "A," "B," and "C," for the purpose of computing and classifying the coal reserves

Area beneath which the Coal City coal is less than 14 inches thick or beneath which its thickness is unknown

Area thought to be mined out

2× Prospect pit or outcrop

3> Portal of slope mine

16 ○ U. S. Bureau of Mines diamond drill hole to the Coal City coal bed

Fault (Dashed where concealed)

Outcrop of coal

Strip pit

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

Carbonaceous claystone

Claystone

Clay

Siltstone

The thicknesses of the beds are shown in inches at the right of the sections

MAP AND SECTIONS OF THE COAL CITY COAL BED

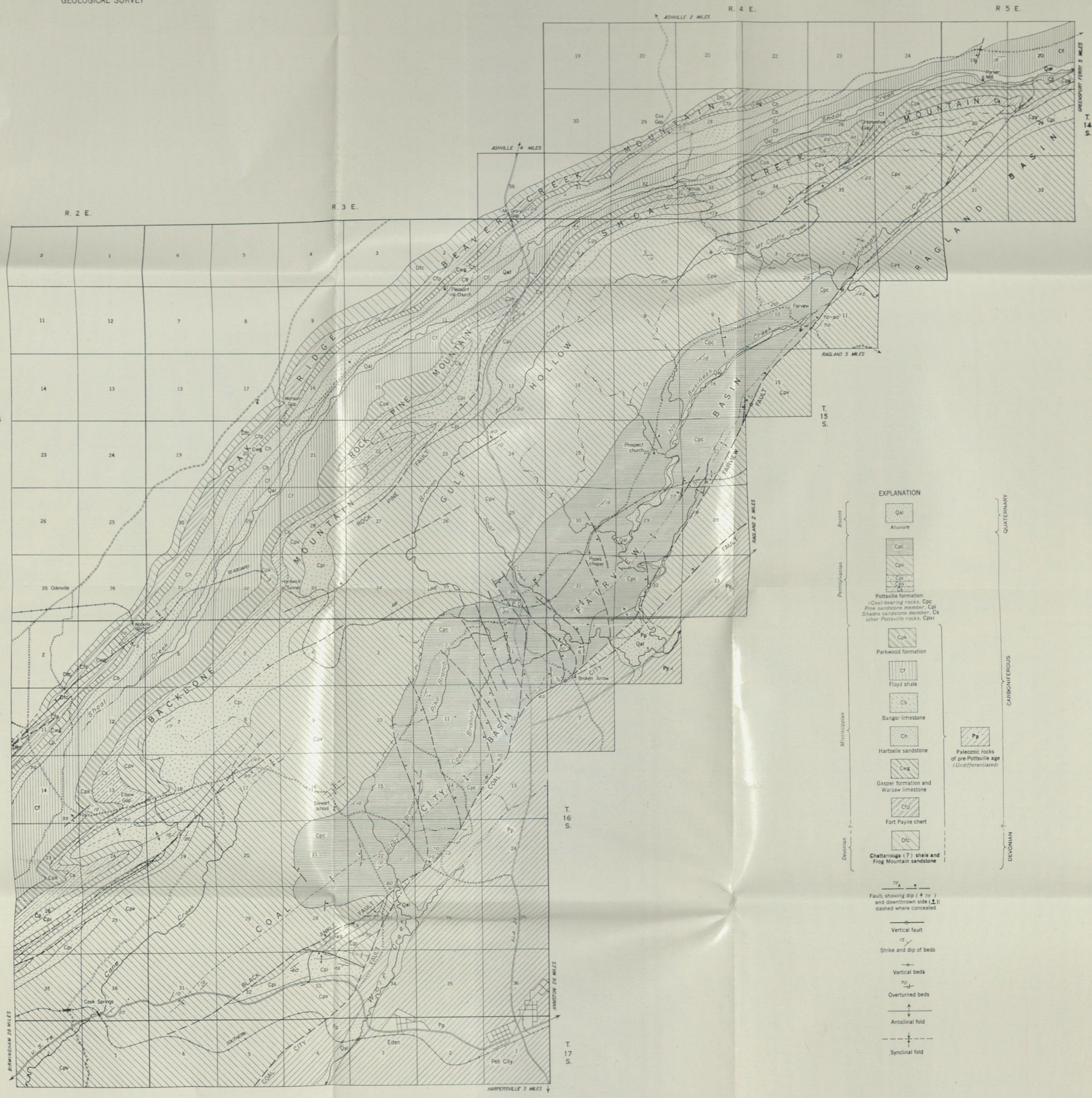
BY
HOWARD E. ROTHROCK

0 500 1000 2000 3000 4000 5000 Feet

1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 1



EXPLANATION

- Qal — Alluvium (Recent)
- Cpc, Cpv, Cpi, Cs — Pottsville formation (Coal-bearing rocks, Cpc; Pine sandstone member, Cpi; Shades sandstone member, Cs; other Pottsville rocks, Cpv) (Pennsylvanian)
- Cpk — Parkwood formation (Pennsylvanian)
- Cf — Floyd shale (Pennsylvanian)
- Cb — Bangor limestone (Mississippian)
- Ch — Hartselle sandstone (Mississippian)
- Cwg — Gasper formation and Warsaw limestone (Mississippian)
- Cfp — Fort Payne chert (Mississippian)
- Dfc — Chattanooga (?) shale and Frog Mountain sandstone (Devonian ?)
- Pp — Paleozoic rocks of pre-Pottsville age (Undifferentiated)

QUATERNARY
CARBONIFEROUS
DEVONIAN ?

- Fault, showing dip (75°) and downthrown side; dashed where concealed
- Vertical fault
- Strike and dip of beds (15°)
- Vertical beds
- Overturned beds (70°)
- Anticlinal fold
- Synclinal fold

GEOLOGIC MAP OF A PART OF THE COOSA COAL FIELD AND ADJACENT AREAS, ST CLAIR COUNTY ALABAMA

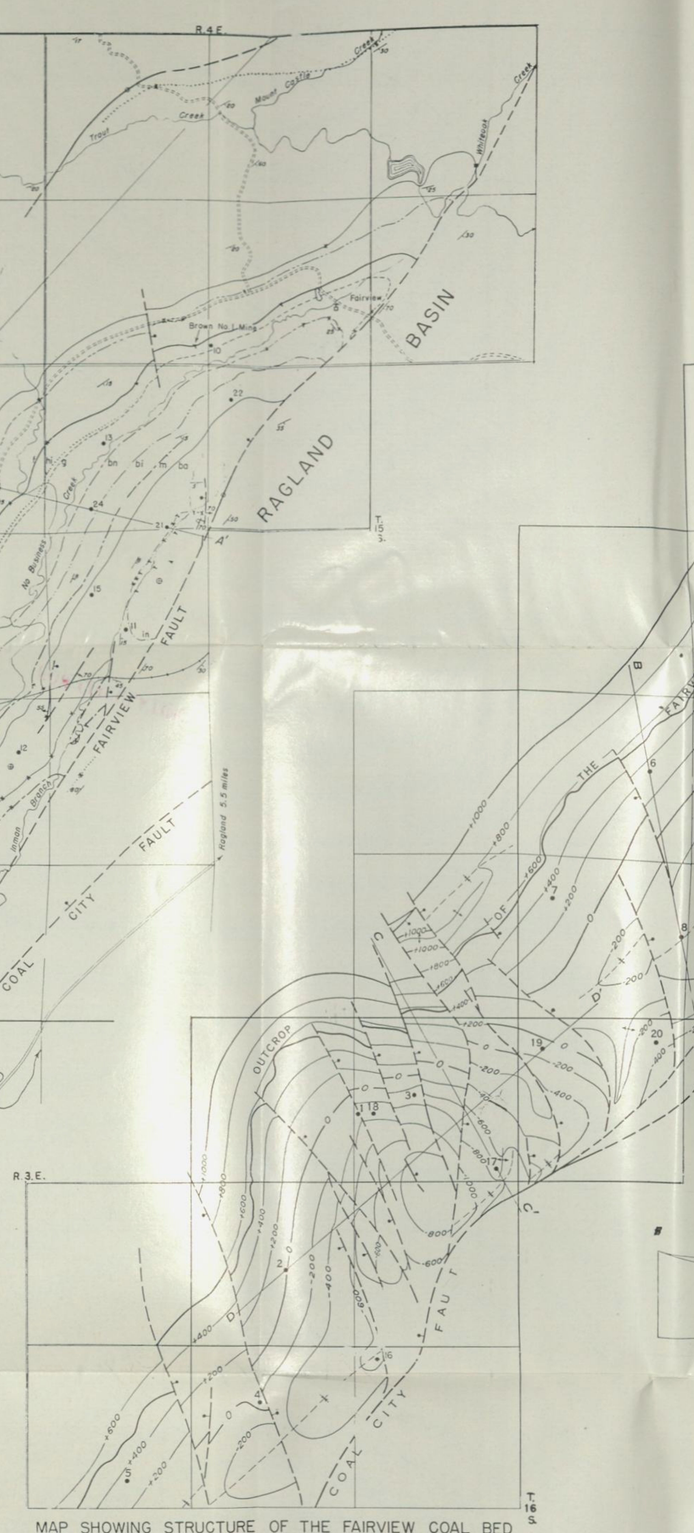
BY HOWARD E. ROTHROCK

0 1/4 1/2 3/4 1 2 3 MILES
5,000 0 5,000 10,000 FEET

1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MAP OF THE COAL CITY AND FAIRVIEW BASINS,
COOSA COAL FIELD, ST. CLAIR COUNTY, ALABAMA
SHOWING COAL OUTCROPS AND STRUCTURE



MAP SHOWING STRUCTURE OF THE FAIRVIEW COAL BED
CONTOUR INTERVAL 200 FEET
DATUM, MEAN SEA LEVEL

PLATE 2

EXPLANATION

COAL BEDS

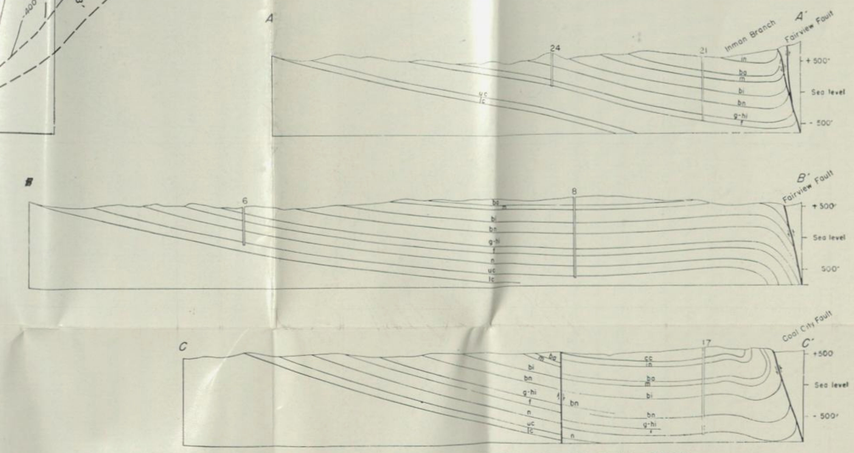
- ha — Hammond
- br — Brewer
- cc — Coal City
- in — Inman
- ba — Broken Arrow
- m — Marion
- bi — Bibby
- bn — Brown
- g — Gann
- hi — Higginbotham
- f — Fairview
- n — New
- uc — Upper Chapman
- lc — Lower Chapman
- Local

WORKINGS

- Small coal prospect, outcrop or bloom of coal
- Portal of slope mine (Fairview coal measured at numbered localities)
- Strip mine
- Diamond drill hole

STRUCTURE SYMBOLS

- Fault, showing dip (Typ) and downthrown side (T) dashed where concealed
- Vertical fault
- Strike and dip of bed
- Strike of vertical bed
- Strike and dip of overturned bed
- Horizontal bed
- Anticlinal fold
- Synclinal fold



SECTIONS SHOWING STRUCTURE OF COAL BEDS

SECTION SHOWING STRUCTURE OF FAIRVIEW COAL BED

Horizontal Scale of Cross Sections
0 1/4 1/2 3/4 MILE

MAPS AND STRUCTURE SECTIONS OF THE COAL CITY AND FAIRVIEW BASINS COOSA COAL FIELD, ST. CLAIR COUNTY, ALABAMA

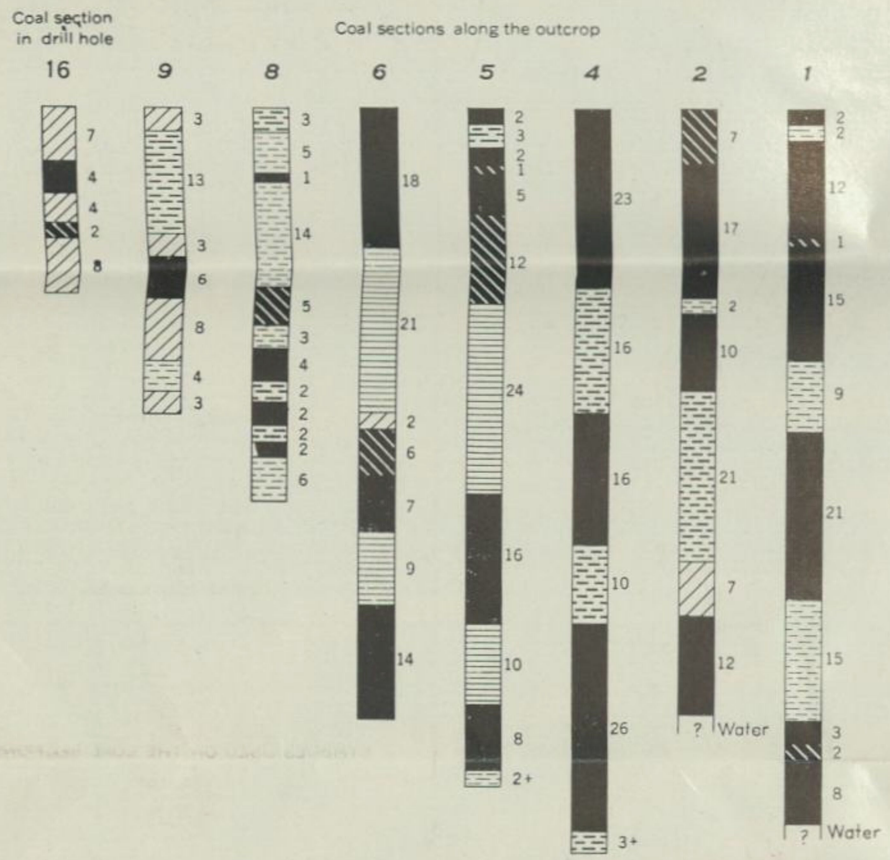
BY
HOWARD E. ROTHROCK

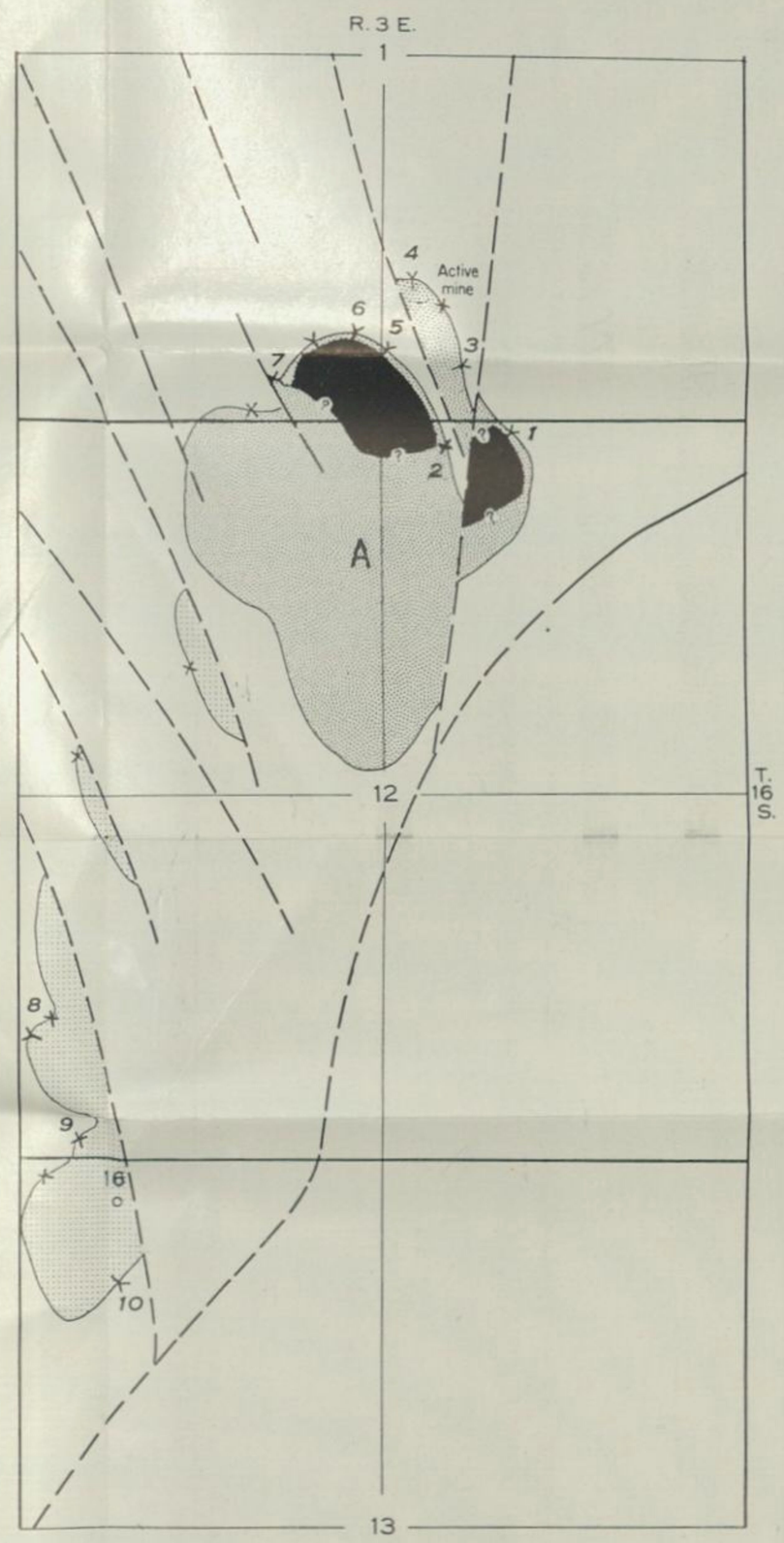
0 1/4 1/2 3/4 1 2 MILES
5,000 4,000 3,000 2,000 1,000 0 5,000 FEET

1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 10





EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Hammond coal is 14 or more inches thick. Block "A" constitutes the minable reserves in this bed

Area beneath which the Hammond coal is less than 14 inches thick or beneath which its thickness is unknown

Area thought to be mined out

2× Prospect pit or outcrop

3>— Portal of slope mine

16 ○ U. S. Bureau of Mines diamond drill hole to the Hammond coal bed

Fault (Dashed where concealed)

Outcrop of coal

Strip pit

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

Carbonaceous claystone

Claystone

Clay

The thicknesses of the beds are shown in inches at the right of the sections

MAP AND SECTIONS OF THE HAMMOND COAL BED

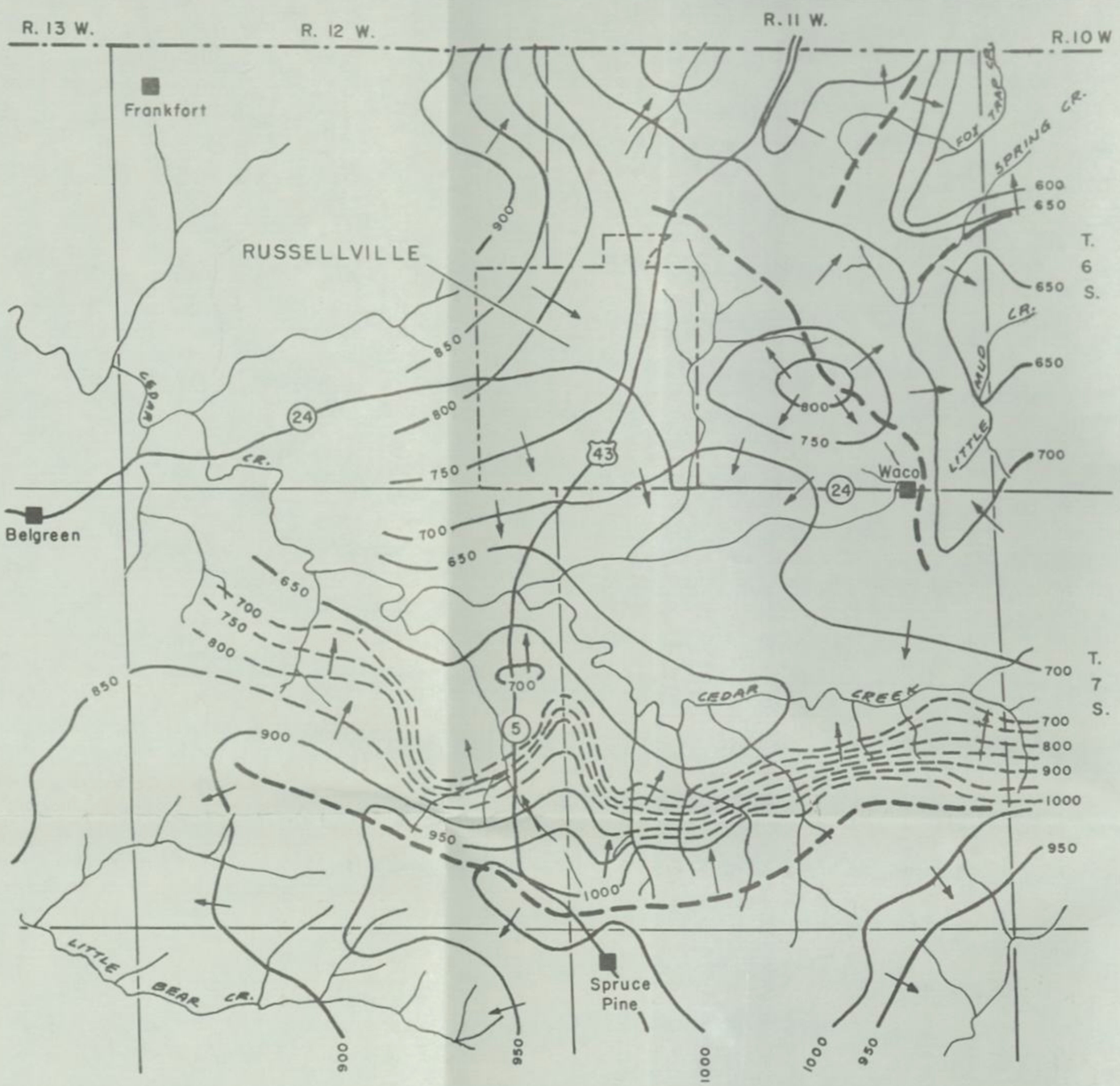
BY
HOWARD E. ROTHROCK

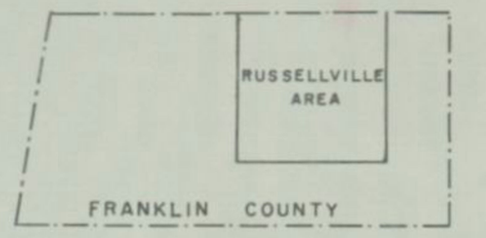
0 500 1000 2000 3000 4000 5000 Feet

1948

A
QE
81
.A15
no.77
c.3

NON CIRCULATING





EXPLANATION

700

Water level contour; dashed where inferred, number is altitude, in feet above mean sea level

Direction of ground water movement

Approximate surface drainage divide

Community or city boundary

43 or 5

Highway, Federal or State

0 1 2 Miles

Scale

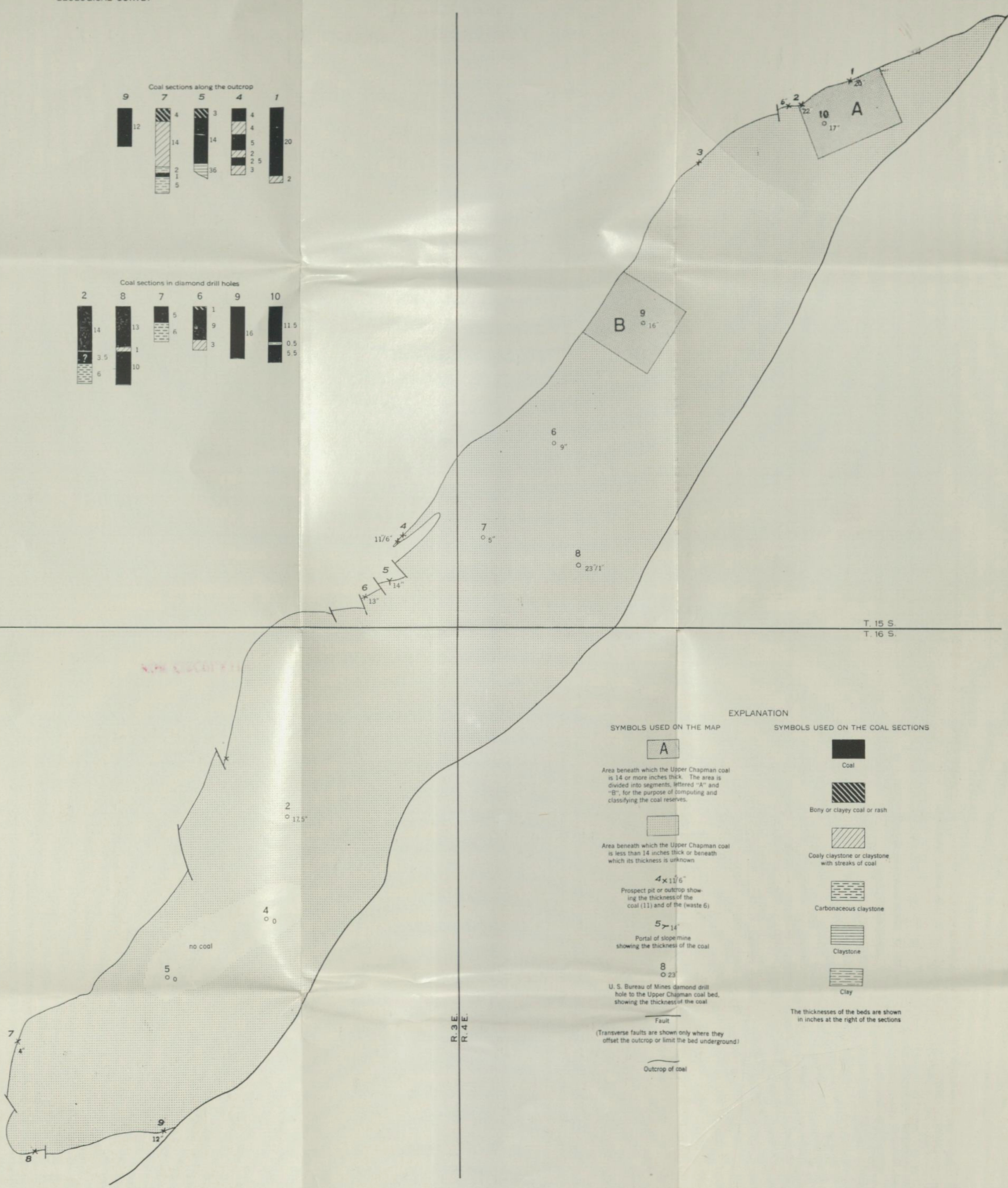
GROUND-WATER MOVEMENT IN THE RUSSELLVILLE AREA, 1961

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 4

Coal sections along the outcrop

Coal sections in diamond drill holes



EXPLANATION

SYMBOLS USED ON THE MAP

A

Area beneath which the Upper Chapman coal is 14 or more inches thick. The area is divided into segments, lettered "A" and "B", for the purpose of computing and classifying the coal reserves.

Area beneath which the Upper Chapman coal is less than 14 inches thick or beneath which its thickness is unknown

4 x 11/6"
Prospect pit or outcrop showing the thickness of the coal (11) and of the (waste 6)

5 > 14"
Portal of slope mine showing the thickness of the coal

8
23"
U. S. Bureau of Mines diamond drill hole to the Upper Chapman coal bed, showing the thickness of the coal

Fault
(Transverse faults are shown only where they offset the outcrop or limit the bed underground)

Outcrop of coal

SYMBOLS USED ON THE COAL SECTIONS

Coal

Bony or clayey coal or rash

Coaly claystone or claystone with streaks of coal

Carbonaceous claystone

Claystone

Clay

The thicknesses of the beds are shown in inches at the right of the sections

MAP AND SECTIONS OF THE UPPER CHAPMAN COAL BED

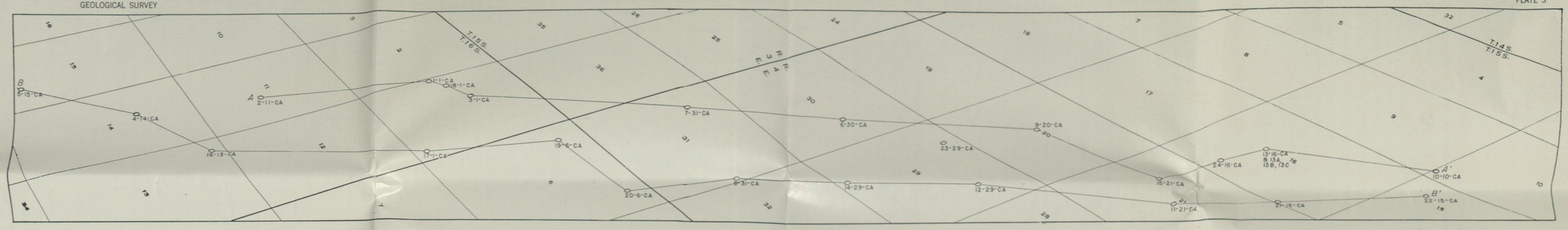
BY
HOWARD E. ROTHROCK

1 ½ 0 1 Mile

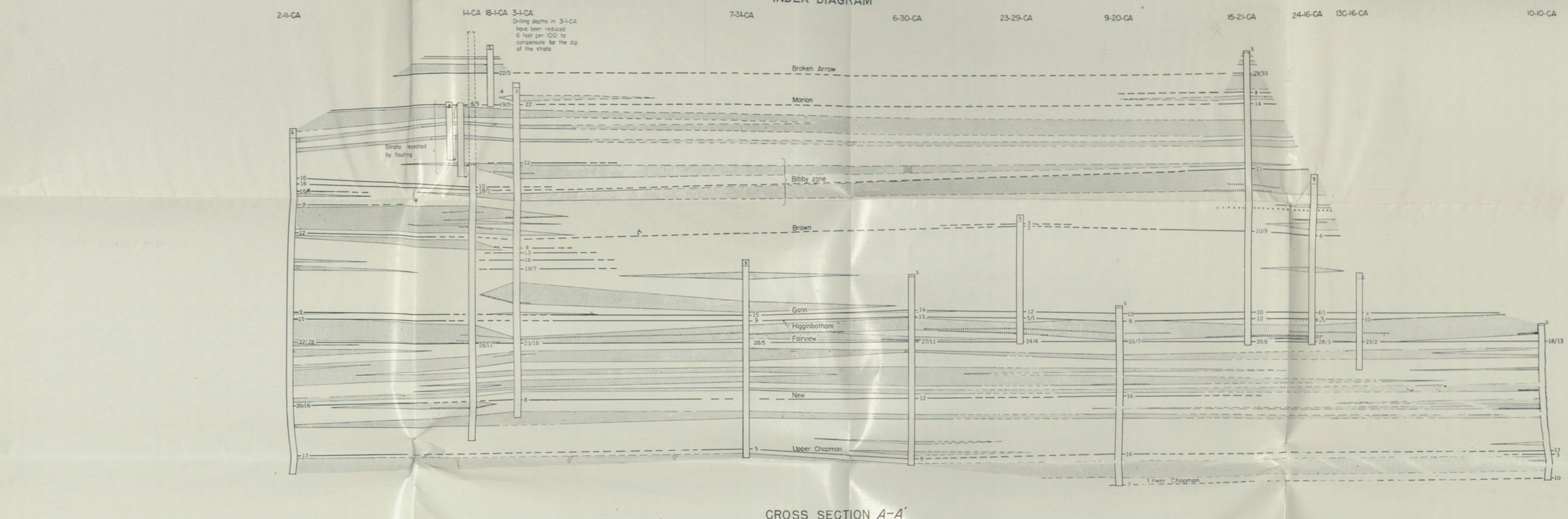
1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

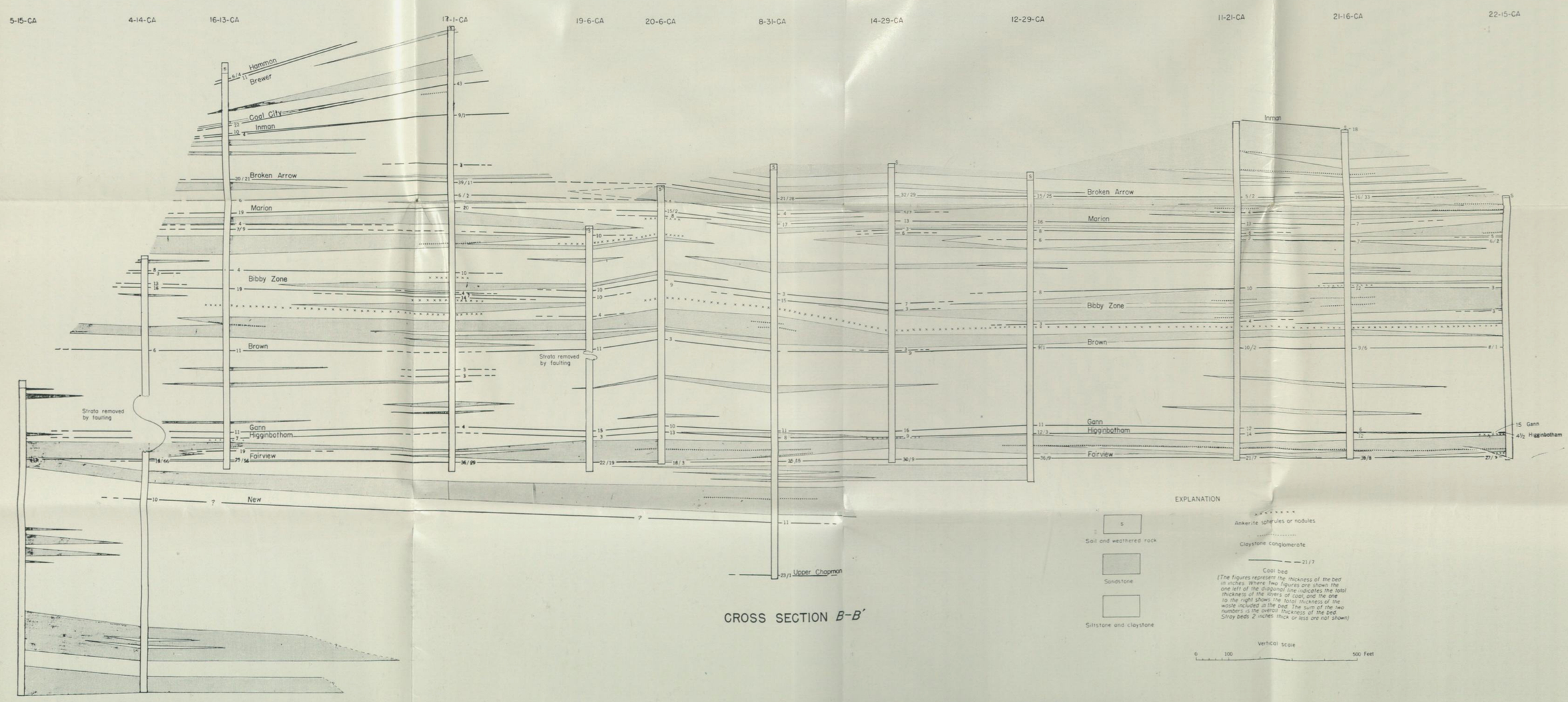
PLATE 3



INDEX DIAGRAM



CROSS SECTION *A-A'*



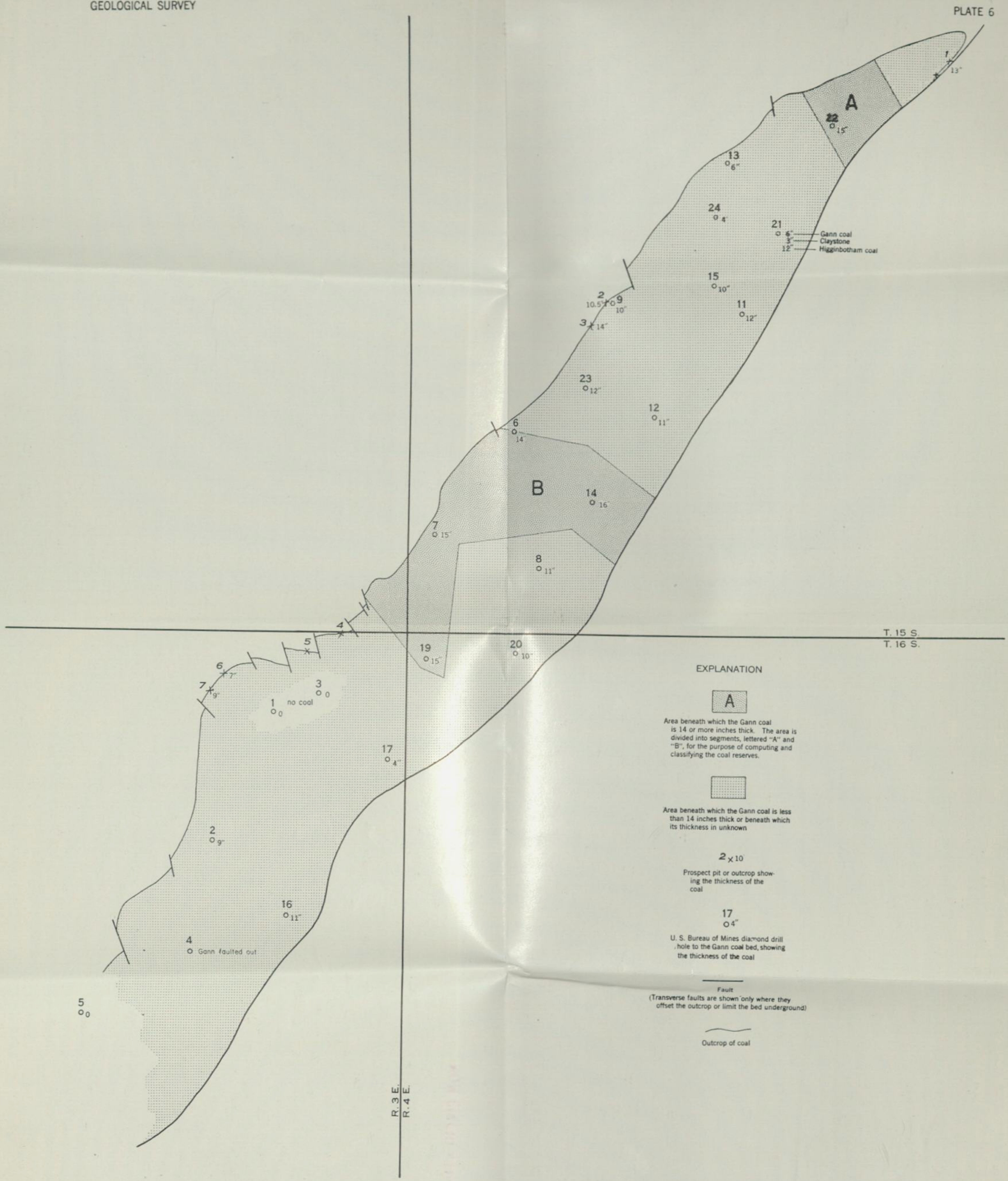
CROSS SECTION *B-B'*

CROSS SECTIONS THROUGH CORE DRILL HOLES, COOSA COAL FIELD, ST. CLAIR COUNTY, ALABAMA

By Howard E. Rothrock, 1948

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PLATE 6



EXPLANATION

A

Area beneath which the Gann coal is 14 or more inches thick. The area is divided into segments, lettered "A" and "B", for the purpose of computing and classifying the coal reserves.

Area beneath which the Gann coal is less than 14 inches thick or beneath which its thickness in unknown

2 x 10

Prospect pit or outcrop showing the thickness of the coal

17
0 4"

U. S. Bureau of Mines diamond drill hole to the Gann coal bed, showing the thickness of the coal

Fault
(Transverse faults are shown only where they offset the outcrop or limit the bed underground)

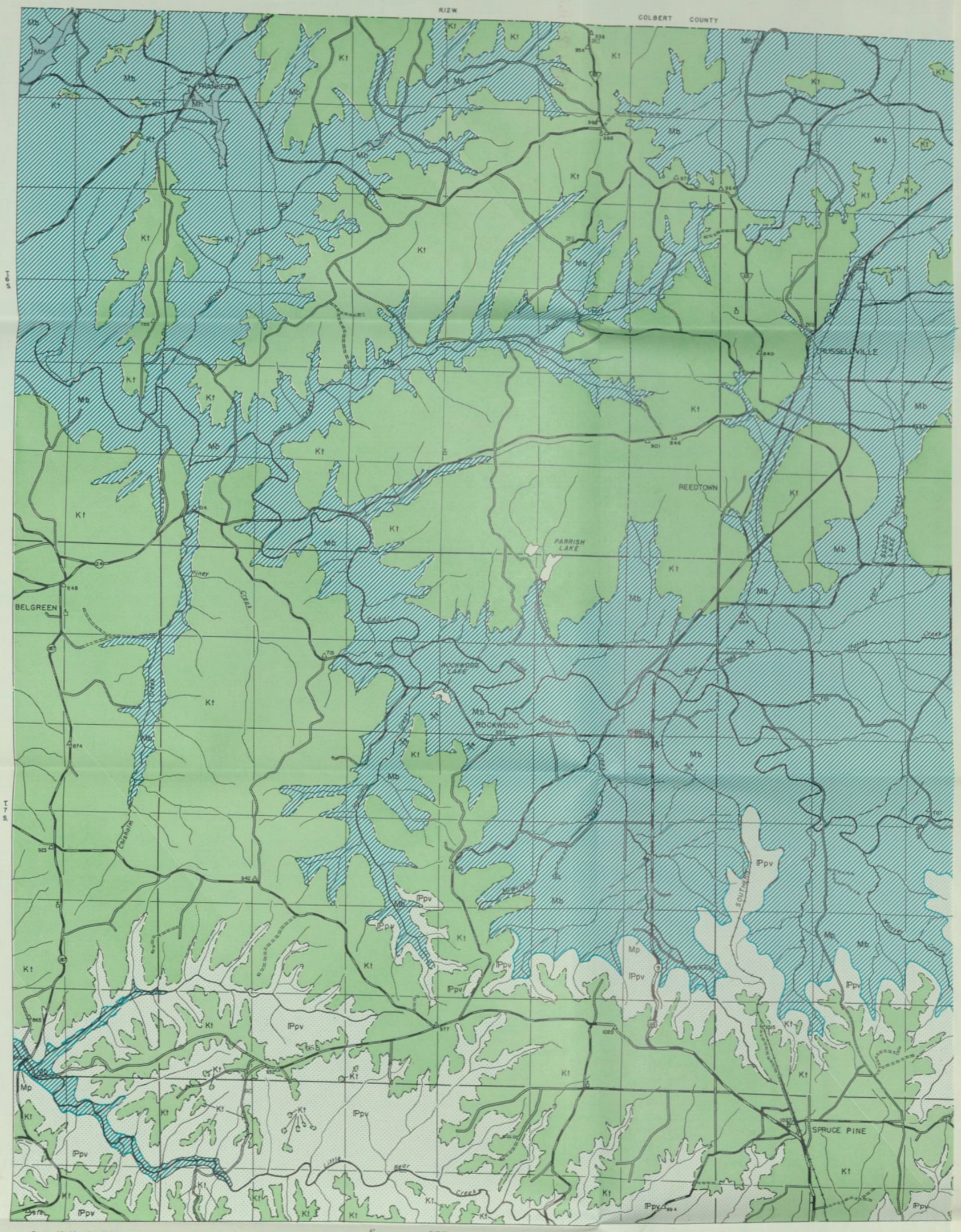
Outcrop of coal

MAP OF THE GANN COAL BED

BY
HOWARD E. ROTHROCK

1 ½ 0 1 Mile

1948



Base modified from TVA-USGS topographic quadrangle sheets

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with
WATER and SEWAGE BOARD
of the
CITY OF RUSSELLVILLE
and the
GEOLOGICAL SURVEY OF ALABAMA

R.12 W.

TRUE NORTH
MAGNETIC NORTH

APPROXIMATE MEAN
DECLINATION, 1945

GEOLOGIC MAP OF THE RUSSELLVI

By Richard R. Peace, Jr.
1963